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CALIFORNIA STATE MINING BUREAU

FERRY BUILDING, SAN FRANCISCO

FLETCHER HAMILTON — State Mineralogist

San Francisco] BULLETIN No. 74 [August, 1917

California Mineral Production for 1916

WITH COUNTY MAPS

By WALTER W. BRADLEY, Mining Statistician

CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO
1917

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LETTER OF TRANSMITTAL.

August, 1917.

To His Excellency, the HONORABLE WILLIAM D. STEPHENS,
Governor of the State of California,

Sir: I have the honor to herewith transmit Bulletin No. 74 of the State Mining Bureau, being the annual report of the statistics of mineral production of California.

The remarkable variety, total valuation, and wide distribution of many of our minerals shown herein are a revelation of California's strategic importance as a producer of commercial minerals among the states of the Union.

Respectfully submitted.

FLETCHER HAMILTON,
State Mineralogist.

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LETTER OF INTRODUCTION.

The Bulletin herewith presented of the mineral industries of California is the result of a painstaking effort to so compile the statistics of production that they will be of actual use to producers and to those interested in the utilization of the mineral products of our state, while at the same time keeping the individual's data confidential. In addition to the mere figures of output, we have included descriptions of the uses and characteristics of many of the materials, as well as a brief mention of their occurrences.

The compilation of accurate and dependable figures is an extremely difficult undertaking, and the State Mineralogist takes the opportunity of here expressing his appreciation of the universal co-operation of the producers in making this work possible. The response to our request for early replies is particularly pleasing. A fuller appreciation of the value of early responses to the requests sent out at the beginning of each year, will result in earlier publication of the data in the future.

Some of the data relative to properties and uses of many of the minerals herein described are repeated from the preceding year's report, as it is intended that this annual statistical bulletin shall be somewhat of a compendium of information on California's commercial minerals and their utilization.

FLETCHER HAMILTON,
State Mineralogist.

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MINERAL INDUSTRY, CALIFORNIA, 1916

DATA COMPILED FROM DIRECT RETURNS FROM PRODUCERS IN ANSWER TO INQUIRIES SENT OUT BY CALIFORNIA STATE MINING BUREAU, FERRY BUILDING, SAN FRANCISCO, CAL.

CHAPTER ONE.

Mineral output in California during the year 1916 amounted to $127,901,610 worth of crude materials. There were fifty-two different mineral substances, exclusive of a segregation of the various stones grouped under gems, and of the fifty-eight counties in the state all but one contributed some mineral product.

As compared with the 1915 output, the notable features of 1916 are the continued increases along those lines which have been boosted by war conditions, the enormous increase in petroleum valuation though the quantity showed a decrease of nearly a million barrels, and the decrease of over a million dollars in the gold yield. The result is a net increase in the grand total value of $31,238,241 over the 1915 total. This is the first time in the history of California that her total mineral yield for a year has passed the one hundred million mark.

Of the metals: Copper increased approximately 15,000,000 pounds in quantity and $6,559,450 in value. Gold decreased $1,031,555. Lead, quicksilver, silver and zinc each increased more than a half million in value, while tungsten showed an increase of 150 per cent in quantity and 350 per cent in value, or $3,566,054.

Petroleum decreased nearly a million barrels in quantity, but the prices per barrel for all grades were raised so materially that the net result was an increase of $13,917,497 in total value.

Decided gains are shown by some of the structural and industrial materials, such as cement, chromite, granite, lime, magnesite and manganese. Of these, magnesite leads with a nearly four-fold increase, of $1,028,432.

All of the salines increased, but especially, borax from $1,663,521 to $2,409,375 and potash from $19,391 to $663,605.

The figures of the State Mining Bureau are made up from reports received direct from the producers of the various minerals. Care is exercised in avoiding duplication, and any error is likely to be on the side of under- rather than over-estimation.

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California yields commercially a greater number and variety of mineral products than any other state in the United States, and probably more than any other equal area elsewhere of the earth. Previous to 1916, the total annual value of her output was surpassed by but four other states, they being the great coal and iron producers of east of the Mississippi River. In 1916, because of their enormous increases in copper output, reports indicate that Montana and Arizona have passed California for that year. Of one item, at least, borax, California still remains the sole producer; and until quite recently, was also the sole domestic source of chromite and magnesite. We produce at least 75% of the quicksilver of the United States. For some years, we have been leading all others in gold and platinum; while alternating in the lead with Colorado in tungsten, and with Oklahoma in petroleum.

Motor trucks have proven a boon in opening up mineral properties hitherto an unprofitable distance from railroad transportation. The advent and improvement of motor vehicles has induced the building of better roads everywhere, thus benefiting the miner and farmer, alike.

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The following table shows the comparative yield of mineral substances of California for 1915 and 1916, as compiled from the returns received at the State Mining Bureau, San Francisco, in answer to inquiries sent to producers:

Substance	1915		1916		Increase + Decrease — Value
	Amount	Value	Amount	Value	
Antimony ore	510 tons	$35,666	1,015 tons	$64,793	$29,127+
Asbestos	143 tons	2,860	145 tons	2,380	480—
Barytes	410 tons	620	1,606 tons	5,516	4,896+
Bituminous rock	17,789 tons	61,468	19,449 tons	66,561	5,093+
Borax	67,004 tons	1,663,521	103,523 tons	2,409,375	745,854+
Brick and tile	180,538 M.	1,678,756	206,960 M.	2,096,570	417,814+
Cement	4,918,275 bbls.	6,044,950	5,299,507 bbls.	6,210,293	165,343+
Chromite	3,725 tons	38,044	48,943 tons	717,244	679,200+
Clay—pottery	157,866 tons	133,724	134,636 tons	146,538	12,814+
Coal	10,299 tons	26,662	4,037 tons	7,030	19,632—
Copper	40,968,966 lbs.	7,169,567	55,809,019 lbs.	13,729,017	6,559,450+
Dolomite	4,192 tons	14,504	13,313 tons	46,566	32,062+
Feldspar	1,800 tons	9,000	2,680 tons	14,350	5,350+
Fuller's earth	692 tons	4,002	110 tons	550	3,452—
Gems		3,565		4,752	1,187+
Gold		22,442,296		21,410,741	1,031,555—
Granite		227,928		535,339	307,411+
Graphite			29,190 lbs.	2,335	2,335+
Gypsum	20,200 tons	48,953	33,384 tons	59,533	10,580+
Infusorial and diatomaceous earths	12,400 tons	62,000	15,322 tons	80,649	18,649+
Iron ore	724 tons	2,584	3,000 tons	6,000	3,416+
Lead	2,398 tons	225,426	6,196 tons	855,049	629,623+
Lime	356,534 lbs.	296,304	493,635 lbs.	390,475	104,171+
Limestone	146,324 tons	156,288	187,521 tons	217,733	61,445+
Lithia	91 tons	1,365	71 tons	1,065	300—
Magnesite	30,721 tons	283,461	154,052 tons	1,311,893	1,028,432+
Magnesium chloride			851 tons	6,407	6,407+
Manganese ore	4,013 tons	49,098	13,404 tons	274,601	225,503+
Marble	22,186 cu. ft.	41,518	25,954 cu. ft.	50,280	8,762+
Mineral paint	311 tons	1,756	643 tons	3,960	2,204+
Mineral water	2,274,267 gals.	467,738	2,273,817 gals.	410,112	57,626—
Molybdenum ore			8 tons	9,945	9,945+
Natural gas	21,992,892 M. cu. ft.	1,706,480	28,134,365 M. cu. ft.	2,871,751	1,165,271+
Petroleum	91,146,620 bbls.	43,503,837	90,262,557 bbls.	57,421,334	13,917,497+
Platinum	667 ounces	21,149	886 ounces	42,642	21,493+
Potash	1,076 tons	19,391	17,908 tons	663,605	644,214+
Pumice and volcanic ash	380 tons	6,400	1,246 tons	18,092	11,692+
Pyrite	92,462 tons	293,148	120,525 tons	372,969	79,821+
Quicksilver	14,199 flasks	1,157,449	21,427 flasks	2,003,425	845,976+
Salt	169,028 tons	368,737	186,148 tons	455,695	86,958+
Sandstone	63,350 cu. ft.	8,438	17,270 cu. ft.	10,271	1,833+
Silica (sand and quartz)	28,904 tons	34,322	20,880 tons	48,908	14,586+
Silver		851,129		1,687,345	836,216+
Slate	1,000 squares	5,000			5,000—
Soapstone and talc	1,663 tons	14,750	1,703 tons	9,831	4,919—
Soda	5,799 tons	83,485	10,593 tons	264,825	181,340+
Stone, miscellaneous*		4,783,180		4,171,519	611,661—
Strontium			57 tons	2,850	2,850+
Tungsten concentrates	962 tons	1,005,467	2,270 tons	4,571,521	3,566,054+
Zinc	13,043,411 lbs.	1,617,383	15,950,565 lbs.	2,137,375	519,992+
Totals		$96,663,369		$127,901,610	
Net increase					$31,238,241+

*Includes macadam, ballast, rubbie, rip-rap, paving blocks, sand, gravel, and grinding mill pebbles.

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The following table shows the comparative value of the mineral production of the various counties in the state for the years 1915 and 1916.

County	1915	1916
Alameda	$861,683	$1,094,167
Alpine		
Amador	4,063,762	3,811,428
Butte	1,622,245	1,356,925
Calaveras	2,161,893	2,965,592
Colusa	16,003	42,808
Contra Costa	1,309,505	1,279,060
Del Norte	4,524	2,432
El Dorado	428,336	470,687
Fresno	8,152,300	8,061,193
Glenn	46,667	81,162
Humboldt	358,686	274,895
Imperial	77,433	105,333
Inyo	2,771,042	4,600,096
Kern	25,335,184	37,826,907
Kings	18,608	26,788
Lake	72,534	180,996
Lassen	870	9,725
Los Angeles	4,168,612	4,463,045
Madera	145,063	222,758
Marin	160,528	178,306
Mariposa	412,326	487,971
Mendocino	24,536	55,680
Merced	94,032	81,530
Modoc	8,681	3,559
Mono	109,425	240,990
Monterey	84,986	109,872
Napa	884,221	1,078,537
Nevada	3,492,946	3,744,143
Orange	6,617,112	8,905,086
Placer	963,860	1,042,629
Plumas	745,715	1,399,335
Riverside	1,349,591	1,234,252
Sacramento	2,562,281	2,178,674
San Benito	642,065	1,213,447
San Bernardino	2,674,042	6,569,147
San Diego	211,129	397,168
San Francisco	128,270	76,437
San Joaquin	248,394	468,862
San Luis Obispo	227,632	245,807
San Mateo	177,891	135,408
Santa Barbara	3,984,966	4,535,029
Santa Clara	635,229	851,948
Santa Cruz	1,581,531	1,679,111
Shasta	8,350,133	13,639,508
Sierra	729,518	729,497
Siskiyou	514,094	580,896
Solano	1,335,923	1,205,335
Sonoma	276,104	472,048
Stanislaus	191,771	253,022
Sutter		6,450
Tehama	4,702	54,353
Trinity	499,511	846,561
Tulare	184,599	947,200
Tuolumne	1,171,438	1,004,262
Ventura	904,767	1,135,430
Yolo	2,040	300
Yuba	2,862,430	3,237,828
Totals	$96,663,369	$127,901,610

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CHAPTER TWO.

FUELS.

Among the most important mineral products of California are its fuels. This subdivision includes coal, natural gas and petroleum, the combined values of which make up approximately 50 per cent of the state's entire mineral industry. Comparison of values during 1915 and 1916 is shown in the following table:

Substance	1915		1916		Increase+ Decrease— Value
	Amount	Value	Amount	Value	
Coal	10,299 tons	$26,662	4,037 tons	$7,030	$19,632—
Natural gas	21,992,892 M. cu. ft.	1,706,480	28,131,365 M. cu. ft.	2,871,751	1,165,271+
Petroleum	91,146,620 bbls.	43,503,837	90,262,557 bbls.	57,421,334	13,917,497+
Totals		$45,236,979		$60,300,115	
Net increase					$15,063,136+

COAL.

Bibliography: State Mineralogist Reports VII, XII, XIII, XIV. U. S. G. S., Bulletins 285, 316, 431, 471, 581; An. Rep. 22 Pt. III.

Coal has been produced in California since as early as 1860, and until the development of crude oil was an important factor in the mineral industry of the state. As most of it is lignite, the quality is generally poor as compared with other coals on the Pacific Coast markets. However, in competition with fuel oil, coal of all grades has had to take second place. Besides the counties noted below as showing a commercial production, workable bodies of coal are also known in several others, including Alameda, Mendocino, Shasta, Siskiyou and Riverside.

During 1916, there was a production reported from Amador and Contra Costa counties, totaling 4,037 tons, worth $7,030. In the first named county, most of the product was briquetted before placing on the market.

Though no exact figures of output previous to 1887 are available, it is known that many hundred thousand tons were shipped from the Mount

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Diablo district, Contra Costa County, between the years 1860 and 1887. Since 1887, the annual output of coal has been as follows:

Year	Tons	Value	Year	Tons	Value
1887	50,000	$150,000	1903	93,026	$265,383
1888	95,000	380,000	1904	79,062	376,494
1889	121,280	288,232	1905	46,500	144,500
1890	110,711	283,019	1906	24,850	61,600
1891	93,301	204,902	1907	23,734	55,849
1892	85,178	209,711	1908	18,496	55,503
1893	72,603	167,555	1909	49,389	216,913
1894	59,887	139,862	1910	11,033	23,484
1895	79,858	193,790	1911	11,047	18,297
1896	70,649	161,335	1912	14,484	39,092
1897	87,449	196,255	1913	25,198	85,809
1898	143,045	337,475	1914	11,859	28,806
1899	160,941	420,109	1915	10,299	26,662
1900	176,956	535,531	1916	4,037	7,030
1901	150,724	401,772			
1902	88,460	248,622	Totals	2,069,056	$5,723,592

NATURAL GAS.

Bibliography: State Mineralogist Reports VII, X, XII, XIII, XIV. Bulletins 3, 16, 19, 69, 73.

Statistics on the production of natural gas in California have been largely guesswork in the past, though each year becoming less so, as more data are available. The figures here given are certainly far below the actual production, particularly in the six oil-producing counties. It is an exceptional oil property where gas in some quantity does not occur. Many oil-producing concerns make no mention of their gas, because they have no method of measuring it, and it is so widely used in the oil fields that it is frequently as lightly regarded as sunshine or fresh air. Doubtless, considerable gas is wasted, but a sweeping condemnation of operators should not be indulged in. It must be remembered that several of our important oil fields are removed many miles from the site of any other industry, and that the gathering of small amounts of gas and transporting it for any considerable distance, may not always be profitable. However, it is undoubtedly a fact that greater saving can frequently be made with profit. Gas traps of various size and design are coming into more frequent use. Some large operators are making commendable efforts to conserve the gas which accompanies oil and is richer than the so-called "dry gas" occurring in strata which do not produce oil. As far as possible, casing-head gas is used in driving gas engines for pumping and drilling, and in firing the boilers of steam-driven plants.

In a hearing before the California Railroad Commission, in May, 1916, relative to gas rates in the Los Angeles territory, part of the testimony showed in the Midway field 46,600,000 cubic feet of natural gas

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available per 24 hours. This is made up of 28,750,000 feet from the dry gas wells and 17,850,000 feet from wells producing both gas and oil. It was estimated that this supply would have a life of from seven to ten years. The Midway pipe line is capable of transmitting 23,000,000 cubic feet per day.

It will be noted that several counties produce gas which is not accompanied by oil, particularly Sacramento and San Joaquin where it is mixed with manufactured gas for domestic service.

The value of gas as here shown may be open to some question, but is certainly not too high, as regards the oil counties. The average price is about 6¢ per 1,000 cubic feet. Approximately 7,000 cu. ft. of gas is equal to one barrel of oil in heating value, and is so accounted for by many operators. In driving gas engines, about 4,000 cu. ft. per 24 hr. are consumed by a 25 h.p. engine, and 63,700 cu. ft. per day for heating a 70 h.p. steam boiler, which figures have been used in compiling this report.

Natural Gas, 1916.

County	M cubic feet	Value
Fresno	2,346,917	$163,941
Kern	16,679,658	1,379,033
Kings	258	608
Los Angeles	2,083,664	139,522
Orange	2,278,922	139,281
San Joaquin	182,441	141,605
Santa Barbara	3,660,410	724,746
Ventura	806,540	133,867
Humboldt, Sacramento, Solano, and Tehama*	95,555	49,148
Totals	28,134,365	$2,871,751

*Combined to conceal an individual producer in each.

The annual production of natural gas in California since 1888 is as follows:

Year	Value	Year	Value
1888	$10,000	1904	$91,025
1889	12,680	1905	102,479
1890	33,000	1906	109,489
1891	30,000	1907	114,759
1892	55,000	1908	474,584
1893	68,500	1909	616,932
1894	79,072	1910	1,676,367
1895	112,000	1911	491,859
1896	111,457	1912	940,076
1897	62,657	1913	1,053,292
1898	74,424	1914	1,049,470
1899	95,000	1915	1,706,480
1900	34,578	1916	2,871,751
1901	92,034		
1902	99,443		
1903	74,237	Total	$12,342,655

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Gasoline from Natural Gas.

As above indicated, more or less gas usually accompanies the petroleum in the oil fields. A number of plants are in operation manufacturing gasoline by compression from this "casing-head gas." This subject was investigated by the U. S. Bureau of Mines and the U. S. Geological Survey, and described in considerable detail by G. A. Burrell et al.,[1] and J. D. Northrup.[2] A valuable article also appeared in one of the trade journals.[3] Upon the enlargement of its engineering force, in the near future, the Department of Petroleum and Gas, of the State Mining Bureau, intends to conduct a more detailed investigation of natural gas production with the idea of being able to point out means of more economical use of this splendid natural resource.

The largest natural gas field of commercial importance thus far developed in California is in the Midway district, followed by Santa Barbara, Orange and Los Angeles counties, in the order named. The Southern California Gas Company operates a 12-inch pipe line from the Midway field, a distance of 107 miles, to Los Angeles, where it supplies gas to local distributing companies. The Valley Natural Gas Company supplies gas to consumers in the Midway field and to local distributing companies at Fellows, Taft, Maricopa, Bakersfield, and the Kern River fields. The Santa Maria Gas and Power Company distributes gas around Santa Maria, from wells in the neighboring oil fields.

There were in operation in 1916 a total of 31 plants making casing-head gasoline by compression, with a total daily capacity estimated at 61,400 gallons, distributed as follows:

Field	Number plants	Gallons daily
Coalinga	1	2,000
Whittier-Fullerton	9	15,850
Midway	8	16,700
Santa Maria	7	19,900
Salt Lake (Los Angeles)	3	3,600
Ventura	3	3,350
Totals	31	61,400

At Santa Maria, after the gasoline is extracted, the remaining "dry gas" is taken into the pipe lines of the Santa Maria Gas and Power Company, by whom it is distributed to consumers, both domestic and commercial.

In the Midway field, some of the casing-head gasoline is obtained as an incidental product to the compressing of the natural gas preliminary

[1] U. S. Bur. of Mines, Bull. 88.
[2] U. S. G. S., Min. Res. 1914, Pt. II, pp. 793–795; 798–800; 804–805.
[3] Oil & Gas Journal, Tulsa, Okla., Jan. 13, 1916, p. 62.

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to transmission through the gas pipe lines. Some concerns market casing-head gasoline separately, while others turn it into the oil pipe lines, thus mixing this high-gravity gasoline with the crude oil for transportation to the refinery, where it is later regained. A total of approximately 18,000,000 gallons of casing-head gasoline from all fields was made during 1916, and utilized directly as such. Santa Barbara County led in this output with a total of 8,867,216 gallons, Kern being second with 6,616,208 gallons.

[4]"There are many peculiarities in connection with the extraction of gasoline from gas that are ascertained only through the closest study. The percentage of gasoline taken from the highest grades of oil, it is natural to infer, is much greater than that taken from low grades of oil, and yet this does not always prove to be the case. Much depends upon the amount of oil produced with the relative amount of gas coming with the oil. For instance, if an oil well is a small producer of oil and a heavy gasser, the percentage of gasoline is much larger than it would be from the same amount of gas coming from a large production of oil. Old wells seem to be more prolific in gasoline than new wells.

"Aside from the Salt Lake field, only a small percentage of the gas coming from low-grade oil has proved to be of commercial value. This is especially true among new producing wells where the oil is of a gravity below 18 degrees.

"It is stated that as a general average gas coming from grades of oil of from 22°–25°, will make from four to six quarts to the thousand feet of gas; from 25°–29° it will average from two to three gallons per thousand feet, and above 29° it will average from three to five gallons per thousand feet.

"The richest gas so far discovered in the state is that found in the old Newhall field. The wells are all very old and small producers of high-gravity oil."

PETROLEUM.

Bibliography: State Mineralogist Reports IV, VII, X, XII, XIII. Bulletins 3, 11, 16, 19, 31, 32, 63, 69, 73.

Chief of the fuels of California is petroleum. A complete description of the industry is to be found in Bulletin 69, issued in 1915 by the State Mining Bureau; supplemented by Bulletin 73, First Annual Report of the Oil and Gas Supervisor for the fiscal year 1915–1916. The state law providing for the regulation of drilling and maintenance of oil and gas wells by the State Mining Bureau has been in effect since 1915. The chief aim is to protect the oil deposits from damage and to aid producers in their work. A staff of technically trained men maintain offices in the various fields. California is certainly not exceeded by any other state in its efforts to accurately keep in touch with the oil business.

The oil production for California for 1916, as determined from the sworn statements made to the State Mineralogist for the Department of Petroleum and Gas, by the 386 producers from 6,873 wells (exclusive of the Los Angeles City field) amounted to 87,063,195 barrels net. "Net" means that a deduction of approximately 2% has been made for water, and that oil consumed for fuel at the wells is not included. This shows a decrease of 1,177,425 barrels from the similar net figures

[4]O. & G. Journal, loc. cit.

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for 1915. When the same deductions for water and fuel have been made from the figures already published by the Standard Oil Company and the Independent Oil Producers Agency, it will be seen that they are in very close agreement with the 87,063,195 barrels above recorded.

Of this total, 39.7% or 34,605,021 barrels was produced by the five large refining and marketing companies, and 14.9% or 12,997,653 barrels by the railroad companies who use the oil in their own service. The remaining 39,460,521 barrels or 54.6% is credited to the smaller producers who usually sell the crude oil at the well.

To the above amount, we have here added 2,914,362 barrels consumed for fuel at the wells, and 285,000 barrels net output of the Los Angeles City fields, making a total gross output for the year 1916 of 90,262,557 barrels valued at $57,421,334. As compared to 1915 this is a decrease of 884,063 barrels in quantity, but an increase of nearly $14,000,000 or 32% in value. This great jump in value is due to the fact that the average price per barrel for all fields and all grades increased from 47.9¢ in 1915 to 63.6¢ in 1916. The total or average figures on price may be open to some question, as it must be remembered that a large portion of the crude oil does not enter the open market, but is consumed or refined directly by the producers. The prices given are for the oil which is actually sold, and are known to be accurate.

The decrease in quantity produced resulted notwithstanding the fact that drilling activity increased the number of producing wells by 464 (as shown by the State Mining Bureau records), and added 6,317 acres to the area of proved oil land; and also, in spite of the incentive of increased demand and prices. The decrease occurred mainly in Santa Barbara County with a loss of 1,132,328 barrels, and the Midway-Sunset field, resulting in Kern County's showing a net loss of 690,160 barrels. Los Angeles and Ventura counties showed small losses. On the other hand, Fresno County increased by 573,221 barrels, and Orange County by 483,134 barrels. San Luis Obispo County again entered the producing list, with a small output. Several causes contributed to the decline. The two prominent ones are: the tying up by Federal suits and withdrawals of the one district of the State which promises the most for future development, namely, the Midway-Sunset; and the fact that in nearly all the fields there is a decline in the number of barrels per well per day yield.

The production figures for 1916 compared with 1915 were:

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Production and Value of Oil by Counties.

County	1915		1916	
	Barrels	Value	Barrels	Value
Fresno	14,021,025	$7,641,459	14,594,246	$7,530,631
Kern	54,810,669	23,184,913	54,120,509	34,691,246
Los Angeles	2,931,098	1,843,661	2,875,468	1,871,930
Orange	12,715,457	6,510,314	13,198,591	8,750,666
San Luis Obispo			11,670	5,252
Santa Barbara	5,634,534	3,442,700	4,502,206	3,574,752
Santa Clara	16,617	11,067	16,368	10,901
Ventura	1,017,220	869,723	943,499	985,956
Totals	91,146,620	$43,503,837	90,262,557	$57,421,334

Average Price of Oil, by Counties, in Cents per Barrel.

County	1914	1915	1916
Fresno	45.2¢	54.5¢	51.6¢
Kern	40.9¢	42.3¢	64.1¢
Los Angeles	55.0¢	62.9¢	65.1¢
Orange	67.5¢	51.2¢	66.3¢
Santa Barbara	46.0¢	61.1¢	79.4¢
Santa Clara	53.0¢	66.6¢	66.6¢
Ventura	105.0¢	85.5¢	104.5¢
State average	46.1¢	47.9¢	63.6¢

The annual production since discovery in 1875 is as follows:

Year	Barrels	Year	Barrels
1875	175,000	1897	1,911,569
1876	12,000	1898	2,249,088
1877	13,000	1899	2,677,875
1878	15,227	1900	4,319,950
1879	19,858	1901	7,710,315
1880	40,552	1902	14,356,910
1881	99,862	1903	24,340,839
1882	128,636	1904	29,736,003
1883	142,857	1905	34,275,701
1884	262,000	1906	32,624,000
1885	325,000	1907	40,311,171
1886	377,145	1908	48,306,910
1887	678,572	1909	58,191,723
1888	690,333	1910	77,697,568
1889	303,220	1911	84,648,157
1890	307,360	1912	89,689,250
1891	323,600	1913	98,494,532
1892	385,049	1914	102,881,907
1893	470,179	1915	91,146,620
1894	783,078	1916	90,262,557
1895	1,245,339		
1896	1,257,780	Total	943,888,292

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The total value since 1887 is as follows:

Year	Value
1887–1909	$136,693,228
1910	37,689,542
1911	40,552,088
1912	41,868,344
1913	48,578,014
1914	47,487,109
1915	43,503,837
1916	57,421,334
Total	$453,793,499

Production by Fields.*

(In barrels of 42 gallons.)

Field	1915	1916	Increase+ Decrease—
Kern River	8,034,974	8,402,525	367,551+
McKittrick	3,552,801	3,230,644	322,157—
Midway-Sunset	39,318,093	38,925,476	392,617—
Lost Hills-Belridge	4,318,550	4,852,431	533,881+
Coalinga	13,548,159	14,381,493	833,334+
Lompoc and Santa Maria	4,536,840	4,422,410	114,430—
Ventura County and Newhall	1,036,305	1,122,033	85,728+
Los Angeles and Salt Lake	2,110,133	1,721,453	388,680—
Whittier-Fullerton	13,030,549	14,679,672	1,649,123+
Summerland	53,000	56,775	3,775+
Watsonville	27,375	27,450	75+
Totals	89,566,779	91,822,362	
Net increase			2,255,583

*Standard Oil Bulletin, January, 1917.

The following table is compiled from the monthly statements of the statistical bureau of the Independent Oil Producers Agency:

Well Operations, by Months, 1916.

Month	Number completed	Producing	Drilling	Abandoned
January	49	6,142	167	23
February	41	6,040	176	11
March	35	6,282	195	4
April	53	6,368	220	21
May	49	6,432	250	29
June	57	6,522	235	33
July	60	6,625	247	6
August	51	6,696	248	8
September	64	6,762	259	19
October	42	6,845	286	25
November	63	6,882	284	14
December	57	6,908	286	20
Totals, 1916	621			213
Totals, 1915	334			176
Totals, 1914	438			129
Monthly average, 1916	52	6,542	238	18
Monthly average, 1915	28	6,015	145	15
Monthly average, 1914	37	5,867	222	11

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The following table is compiled from the monthly statements contained in the Standard Oil Bulletin:

Well Operations, by Fields, 1916.

Field	Producing Dec., 1915	Producing Dec., 1916	Increase+ Decrease—	Completed	Abandoned
Kern River	1,684	1,908	224+	106	5
McKittrick	276	293	17+	21	5
Midway-Sunset	1,418	1,710	292+	209	15
Lost Hills-Belridge	248	350	102+	114	4
Coalinga	804	949	145+	36	11
Santa Maria-Lompoc	237	249	12+	11	12
Ventura County and Newhall	444	446	2+	12	7
Los Angeles and Salt Lake	691	674	17—	2	11
Whittier-Fullerton	613	637	24+	56	10
Summerland	112	112			
Watsonville	5	5			
Totals	6,532	7,333	801+	567	80

The records of the Department of Petroleum and Gas of the State Mining Bureau show 164 wells abandoned during the year. It will be noted that the two foregoing tables are far from being in agreement with this figure or with each other. There is evidently a wide divergence of opinion as to the definition of "abandonment."

The proportion of heavy and light oil produced in the various fields is shown by the following figures, for which we are indebted to the Standard Oil Company. Oil below 18° Baumé may be considered as largely unrefinable, or fuel, oil; while the lighter oils yield varying amounts of refined products and a very large proportion of residuum or fuel oil. A very few years ago, the total amount of heavy oil was in excess of the light oil.

Production of Light and Heavy Oil by Fields, 1916.

Field	Under 18°, barrels	18° and over, barrels	Totals, barrels
Kern River	8,402,525		8,402,525
McKittrick	3,230,644		3,230,644
Midway-Sunset	10,888,980	28,036,496	38,925,476
Lost Hills-Belridge	578,018	4,274,413	4,852,431
Coalinga	5,807,685	8,573,808	14,381,493
Lompoc and Santa Maria	834,945	3,587,465	4,422,410
Ventura County and Newhall	107,698	1,014,335	1,122,033
Los Angeles and Salt Lake	1,624,273	97,180	1,721,453
Whittier-Fullerton	270,454	14,409,218	14,679,672
Summerland	56,775		56,775
Watsonville		27,450	27,450
Totals	31,801,997	60,020,365	91,822,362

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Financial Results.

Financial results of the oil business during 1916, are shown by the following tables. The outstanding features are: 1. the substantial increase of prices for all grades over the 1915 figures; 2. a decrease in nearly all fields in the number of barrels per well per day yield; 3. an increase in operating costs per barrel, resulting in raising the cost per well per day. The profitable, or dividend-paying companies received a slightly higher figure for their product than the average market price, probably due to the higher grade of oil produced by them. It is also noticeable that their production cost per barrel is usually lower than the average, due to the fact that their wells are more productive. Operating cost per well is not always lower for the dividend companies than others. Profitable operations seem to depend generally upon large wells, high-grade oil, and proximity to market. There is nothing to indicate that unnatural causes or manipulations have affected the profits of one producer against another. It may be noted that both price and profits are greater in the Los Angeles–Orange–Ventura fields than in others, doubtless largely due to the proximity to market and high grade of oil.

In addition to consuming the current production of crude oil, the storage was drawn upon at an average rate in excess of 1,000,000 barrels per month during 1916. According to the Standard Oil Company[5], the stocks on hand on December 31, 1916, amounted to 44,036,190 barrels, a decrease of 13,110,861 barrels from the 57,147,051 barrels on hand December 31, 1915. The monthly bulletins of the Independent Oil Producers Agency show practically the same results—43,640,294 barrels, being a decrease of 12,336,886 barrels.

Financial and Operating Condition of California Oil Fields, 1916.

Field	Number of companies considered	Per cent of total product of field	Capital	
			Cash	Property
Coalinga	34	49	$4,312,037	$48,172,544
Kern River	49	36	5,516,743	4,004,737
Midway	64	23	4,393,957	31,659,812
Sunset	23		2,422,351	9,411,338
McKittrick, Lost Hills, Belridge	16	38	603,209	9,601,525
Santa Maria, Lompoc, Summerland	12	73	2,358,963	13,544,251
Ventura	18	13	1,020,693	2,113,170
Los Angeles and Orange	27	20	3,434,155	7,952,843
Subtotals	243		$24,062,128	$126,460,220
Miscellaneous and marketing	25	16	64,523,556	10,958,205
Totals	268		$88,585,684	$137,418,425

[5]Standard Oil Bulletin, January, 1917.

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Dividends Paid by Oil Companies, 1911-1916.

Field	1911		1912		1913		1914		1915		1916	
	Companies	Value	Companies	Value	Companies	Value	Companies	Value	Companies	Value	Companies	Value
Coalinga	14	$1,236,338	15	$1,154,328	17	$956,098	15	$1,048,840	13	$283,660	12	$217,949
Kern River	22	389,822	26	454,095	19	361,444	20	205,258	20	187,962	23	405,556
Midway	18	1,076,285	19	1,128,161	14	520,520	25	917,981	23	853,376	29	1,207,974
Sunset	7	211,339	7	319,220	3	91,936	5	166,152	7	149,932	5	241,200
McKittrick, Belridge and Lost Hills	1	85,000	2	134,945	6	538,744	8	493,339	7	397,827	7	434,184
Santa Maria, Lompoc and Summerland	5	1,000,141	6	374,720	8	500,976	6	480,534	6	317,727	7	293,025
Ventura County	2	46,252	2	26,393	2	54,720	4	125,832	2	120,143	5	126,812
Los Angeles and Orange counties	12	1,288,034	12	878,478	14	3,015,159	13	2,453,981	14	863,677	12	1,222,598
Subtotals	81	$5,333,211	89	$4,470,340	83	$6,039,597	96	$5,891,917	92	$3,174,304	100	$4,149,298
Miscellaneous and marketing companies	5	2,830,403	7	4,401,218	8	9,509,009	9	9,384,308	13	9,926,044	13	*38,383,270
Totals	86	$8,163,614	96	$8,871,558	91	$15,548,606	105	$15,276,225	105	$13,100,348	113	$42,532,568

*Includes a 50% stock dividend of the Standard Oil Company.

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Prices of Light and Heavy Oil and Operating Data, 1916.

Field	Price				Operating data					
					All companies			Dividend companies		
	Under 18° Baume (cents)	18° and over (cents)	Average price (cents)	Price to dividend companies (cents)	Barrels per well per day, yield	Operating cost per well day (dollars)	Operating cost per barrel (cents)	Barrels per well per day, yield	Operating cost per well day (dollars)	Operating cost per barrel (cents)
Coalinga	49.2	63.0	51.6	55.8	37.8	10.02	26.5	25.5	4.21	16.9
Kern River	53.0	----------	53.0	58.7	9.9	2.30	23.2	13.8	3.14	22.8
Midway	62.9	75.8	70.0	63.8	45.1	11.18	24.8	51.3	12.93	25.2
Sunset	68.0	58.2	61.4	61.1	40.5	9.76	24.1	44.2	4.86	11.0
McKittrick, Belridge and Lost Hills	60.8	52.4	55.6	58.0	29.5	3.92	13.3	29.7	3.18	10.7
Santa Maria, Lompoc and Summerland	55.8	87.2	79.4	86.2	42.9	9.18	21.4	40.2	7.72	19.2
Ventura	57.0	107.0	104.5	110.0	11.6	3.92	33.8	15.6	4.20	26.9
Los Angeles and Orange counties	64.2	66.0	65.8	64.0	15.9	3.58	22.6	27.8	4.45	16.0

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Proved Oil Land.

The present extent of proved oil land in California as determined by the State Mining Bureau is 138 square miles, or 86,479 acres, of which 56,122 acres are in Kern County alone. Fresno County is second on the list with 12,703 acres, and Santa Barbara County third with 9,808 acres. The other counties in order of their rank are Orange, Los Angeles, Ventura, San Luis Obispo, and Santa Clara. The increase in the proved oil land area as compared to the 1915 figures was principally in Santa Barbara County in the vicinity of Casmalia and at the Bell ranch, near Santa Maria. It is worthy of notice that the total area of proved oil land is most insignificant in comparison with the area of the entire state, being less than one one-thousandth part, and yet the oil business is one of the state's most important industries.

Estimates of the total amount of oil which can be recovered from the land are little better than pure guesses but it does seem most probable that the average acre will ultimately yield much less than fifty thousand barrels.

The areas of proved land are as follows:

County	Acres	County	Acres
Fresno	12,703	Santa Barbara	9,808
Kern	56,122	San Luis Obispo	772
Los Angeles	2,174	Santa Clara	80
Orange	3,297		
Ventura	1,523	Total	86,479

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CHAPTER THREE.

METALS.

The total value of metals produced in California during 1916 was $46,792,454. The chief of these is, and always has been, gold, followed in order in 1916 by copper, tungsten, zinc, quicksilver, silver, lead, manganese, antimony, platinum, molybdenum and iron. Deposits of ores of nickel and vanadium are also to be found in the state, although for 1916 there was no commercial output of them.

California leads all states in the Union in her gold production and the precious metal is widely distributed throughout the State. Twenty-eight of the fifty-eight counties contain actively operated gold mines or dredges.

Copper, which is second in importance among the metals of the State, occurs in the following general districts: the Shasta County belt, which is by far the most important; the Coast Range deposits, extending more or less continuously from Del Norte in the north to San Luis Obispo County in the south; the Sierra Nevada foothill belt, starting in Plumas and running in a general southerly and southeasterly direction through the Mother Lode counties and ending in Kern; the eastern belt in Mono and Inyo counties; and the southern belt, in San Bernardino, Riverside, and San Diego counties.

Silver is not generally found alone in the state, but is associated to a greater or less extent with gold, copper, lead, and zinc.

Quicksilver has for many years been one of the state's staple products and California supplies at least 75 per cent of the nation's output of this metal.

Tungsten is found in but few other localities of importance in the United States.

Large deposits of iron ore have long been known in many sections of the state, but for various economic reasons this branch of the mineral industry is still in its infancy here.

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A comparison of the 1916 metal output with that of 1915 is afforded by the following table:

Metal	1915		1916		Increase+ Decrease— Value
	Amount	Value	Amount	Value	
Antimony ore	510 tons	$35,666	1,015 tons	$64,793	$29,127+
Copper	40,968,966 lbs.	7,169,567	55,809,019 lbs.	13,729,017	6,559,450+
Gold		22,442,296		21,410,741	1,031,555—
Iron ore	724 tons	2,584	3,000 tons	6,000	3,416+
Lead	2,398 tons	225,426	6,196 tons	855,049	629,623+
Manganese ore	4,013 tons	49,098	13,404 tons	274,601	225,503+
Molybdenum ore			8 tons	9,945	9,945+
Platinum	637 ounces	21,149	886 ounces	42,642	21,493+
Quicksilver	14,199 flasks	1,157,449	21,427 flasks	2,003,425	845,976+
Silver		851,129		1,687,345	836,216+
Tungsten concentrates	962 tons	1,005,467	2,270 tons	4,571,521	3,566,054+
Zinc	13,043,411 lbs.	1,617,383	15,950,565 lbs.	2,137,375	519,992+
Totals		$34,577,214		$46,792,454	
Net increase					$12,215,240+

ALUMINUM.

Bibliography: Bulletins 38, 67.

No workable deposits of bauxite have been discovered in the state, although from time to time small quantities of the impure material have been the foundation of extravagant reports regarding such discoveries.

ANTIMONY.

Bibliography: State Mineralogist Reports XII, XIII, XIV. Bulletin 38.

Antimony is known to exist in a number of places in California, having been reported from Kern, Inyo, Nevada, Riverside, San Benito, and Santa Clara counties. The Kern County deposits, some of which carry metallic antimony, are possibly the best known, and efforts were made to work some of them before California was a part of the United States. The commonest occurrence is in the form of the sulphide, stibnite. No continuous production, however, has been maintained, the output for 1915 being the first reported since 1901.

From the low point of 5.44¢ to 7.11¢ per pound, according to brand in July, 1914, the price of antimony rose gradually, though not steadily to 44¢ by the middle of January, 1916. American antimony, for the first time in many years, appeared on the market in competition with the Chinese and Japanese product. From $1.00 to $2.25 per unit was paid for ore, and at first a minimum of 50% accepted; but, later, some lower grade ore was smelted. The price remained at 44¢ (San Francisco quotations) until the middle of April, then declined quite rapidly to 10¢ in August. It remained around that figure and up to 14¢.

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closing the year at 12¢ per pound and $1.00 per unit. If the price drops below 12¢ per pound for the metal, few if any of the California mines can operate profitably.

During 1916 in California there was mined and sold a total of 1,015 tons of antimony ore, valued at $64,793, by four producers in Kern County and one each in Inyo and San Benito counties. The Wild Rose mine in Inyo County made the largest individual output. As will be noted from the table below, the tonnage for 1916 was nearly equal to the total of all previous years.

The production by years since 1887 has been as follows:

Year	Tons	Value	Year	Tons	Value
1887	75	$15,500	1899	75	$13,500
1888	100	20,000	1900	70	5,700
1893	50	2,250	1901	50	8,350
1894	150	6,000	1915	510	35,666
1895	33	1,485	1916	1,015	64,793
1896	17	2,320			
1897	20	3,500			
1898	40	1,200	Totals	2,205	$180,264

BISMUTH.

Bibliography: Bulletins 38, 67. Am. Jour. Sci. 1903, Vol. 16.

Several bismuth minerals have been found in California, notably native bismuth and bismite (the ochre) in the tourmaline gem district in San Diego and Riverside counties near Pala. Other occurrences of bismuth minerals, including the sulphide, bismuthinite, have been noted in Inyo, Fresno, Nevada, Tuolumne and Mono counties, but only in small quantities. The only commercial production recorded was 20 tons valued at $2,400, in 1904, and credited to Riverside County.

Recovery of bismuth from blister copper in the electrolytic refinery has been noted ([6]), ranging as high as 27.3 pounds of metallic bismuth per 100 tons of blister copper from the Iron Mountain, Shasta County, ores.

The uses of bismuth are somewhat restricted, being employed principally in the preparation of medicinal salts, and in low melting-point or cliché alloys. These alloys are utilized in automatic fire sprinkler systems, in electrical fuses, and in solders.

[6]Trans. Am. Inst. Min. Eng., Vol. 47, pp. 217–218.

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COPPER.

Bibliography: State Mineralogist Reports VII, XIII, XIV. Bulletins 23 and 50.

Copper is one of the staple mineral products of the state, being produced chiefly in Shasta County, with smaller amounts but in excess of one million pounds of copper each, from Calaveras, Placer, Plumas and Trinity counties. In 1916, some yield in greater or less amount, was reported from a total of 25 counties. The production for the year was 55,809,019 pounds, valued at $13,729,017, which is a 37% increase in quantity and nearly double the total value of the previous year. The quantity has been exceeded but once (in 1909), but the value is the greatest in the history of copper mining in California. The European war has caused a greatly increased demand for copper to make brass for shells of all calibers, as well as other requirements. This has raised the price from the 1914 average of 13.3¢ to 17.5¢ per pound in 1915, and 24.6¢ in 1916, the closing December figure being 31.55¢. Quotations reached as high as 35¢ per pound.

Improvements have been made in the methods of handling smelter smoke. Flotation concentration is being successfully employed by the Engels Copper Company and at the Walker Mine in Plumas County, by the Calaveras Copper Company in Calaveras County, and by the Mammoth Copper Company in Shasta County.

Distribution of the output, by counties, for 1916, was as follows:

County	Pounds	Value
Amador	12,349	$3,038
Calaveras	6,099,509	1,500,479
Fresno	29,173	7,177
Inyo	274,032	67,412
Kern	24,754	6,089
Madera	124,286	30,574
Mariposa	162,318	39,930
Nevada	3,487	858
Placer	1,437,441	353,610
Plumas	4,932,928	1,213,500
Riverside	58,617	14,420
San Bernardino	1,577,901	388,164
San Diego	16,806	4,134
San Luis Obispo	356	88
Shasta	39,437,196	9,701,550
Tulare	1,422	350
Tuolumne	1,797	442
Yuba	4,817	1,185
Del Norte, El Dorado, Imperial, Los Angeles, Siskiyou, Trinity*	1,609,830	396,017
Totals	55,809,019	$13,729,017

*Combined to conceal output of individual mines in each.

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Amount and value of copper production in California annually since such records have been compiled by the State Mining Bureau is given in the following tabulation:

Year	Pounds	Value	Year	Pounds	Value
1887	1,600,000	$192,000	1903	19,113,861	$2,520,997
1888	1,570,021	235,303	1904	29,974,154	3,969,995
1889	151,505	18,180	1905	16,997,489	2,650,605
1890	23,347	3,502	1906	28,726,448	5,522,712
1891	3,397,455	424,675	1907	32,602,945	6,341,387
1892	2,980,944	342,808	1908	40,868,772	5,350,777
1893	239,682	21,571	1909	65,727,736	8,478,142
1894	738,594	72,486	1910	53,721,032	6,680,641
1895	225,650	21,901	1911	36,838,024	4,604,753
1896	1,992,844	199,519	1912	34,169,997	5,638,049
1897	13,638,626	1,540,666	1913	34,471,118	5,343,023
1898	21,543,229	2,475,168	1914	30,491,535	4,055,375
1899	23,915,486	3,990,534	1915	40,968,966	7,169,567
1900	29,515,512	4,748,242	1916	55,809,019	13,729,017
1901	34,931,788	5,501,782			
1902	27,860,162	3,239,975	Totals	684,805,941	$105,083,352

GOLD.

Bibliography: State Mineralogist Reports, I to XIV (inc.). Bulletins 36, 45, 57. U. S. G. S., Prof. Pap. 73.

Gold is one of the most important mineral products of California, and its discovery was the prime cause of the rapid early development of the state. There is a marked tendency toward increased activity in gold mining, as investors realize that many of the mines and prospects have not been exhausted. It is absolutely necessary that owners of prospects and small mines, who wish to dispose of their prpoerty or see it developed, should realize that most large investments of that sort are made only after thorough investigation. Frequently, demands for large cash payments have turned away capitalists who would otherwise have been willing to risk an equal amount in development work. Gold dredging continues active, though the peak of the output from that source seems to have been passed.

The State Mining Bureau has never independently collected statistics of gold, platinum and silver production, as there is no necessity for duplicating the very thoroughly organized work of the U. S. Geological Survey covering those metals. The data here given relative to these three metals has been received through the courtesy and coöperation of Mr. Charles G. Yale, Statistician in Charge of the San Francisco branch office of the Division of Mineral Resources. Anyone wishing fuller details of the production of these metals may obtain the same by applying to the U. S. Geological Survey, Washington, D. C., or to

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Room 305, U. S. Custom House, San Francisco, Cal., for a copy of the "separate" on the subject.

"In 1916 there were 589 properties reporting production in California, of which 297 were deep mines and 292 were placers. The producing deep mines of 1916 may be classified by chief metallic product as follows: Gold, 204; copper, 60; silver, 1; silver-lead, 18; lead, 11; and zinc, 3. Of the placer mines 87 were hydraulic, 9 less than in 1915; 60 were dredge, 2 more than in 1915; 67 were drift, 6 more than in 1915; and 78 were surface or sluicing mines, 6 more than in 1915. There were altogether 3 more placer mines producing in 1915. Of deep mines there were 33 less gold mines, 17 more copper, 10 less silver, 15 more silver-lead, and 3 less zinc; there were therefore 24 less deep mines productive than in 1915. The dredges are enumerated by number of boats at work, some companies owning only one, and others several.

"The total value of the gold, silver, copper, lead and zinc produced in California in 1916 shows an increase of 23.2%. There was an increase in quantity and value in all metals, except gold, which showed a decrease of 4.5%. In copper the increase was 37% in quantity and 93% in value; and in zinc it was 16.5% in quantity and 26% in value. The lead output increased 171% in quantity and 298% in value. The increase in silver was 53% in quantity and 98% in value. The yield of gold from deep mines decreased 7% and that from placers 4%.

* * * * * * * * * *

"The total production of gold in California in 1916 was 1,035,744.59 fine ounces, valued at $21,410,741, a decrease of 49,901.48 fine ounces, valued at $1,031,555, or about 4.8% for 1916. The deep mines of the State yielded 620,897.19 fine ounces of gold, valued at $12,835,084. Of the deep mines gold 92.5% was derived from siliceous ore; 7.2% was derived from copper ore; 0.2% from silver-lead ore; and the remainder from lead ores and zinc ores.

"The decrease in the gold output of the state is due almost entirely to the drop of nearly a million dollars from the deep mines, caused by labor strike in the Mother Lode region where the largest producers are situated. Some mines were closed down from 40 to 60 days, product being thus curtailed. The decrease from the placers was only about $33,000. The gold output from surface placers increased to some extent according to returns, but there was a lighter output from the hydraulic, drift, and dredge mines. In the case of the dredges the yield was only $27,338 less than in 1915. Since gold dredging commenced in California in 1898 the total output of gold from that source to the end of 1916 has been $86,873,458. Since 1898 the Oroville (Butte County) dredging field has yielded $29,442,604 in gold, not including $1,973,085 derived in the last seven years from dredges in adjacent districts in the same county. The Marysville (Yuba County) field has produced from 1903 to 1916, inclusive, $27,439,000 in gold. The Folsom (Sacramento County) field has yielded since 1902 from dredging, gold valued at $18,926,531. A number of dredgers are in operation in various localities in other counties of the state, but these figures are not included in the more extensive fields named.

"The placer yield of gold in 1916 was 414,847.40 fine ounces, valued at $8,575,657. The placer mines produced 40% of the total gold yield for 1916 and the deep mines 60%, as compared with 38% for the placers and 62% for the deep mines in 1915. The dredges produced 36% of the total gold yield from all sources in 1916. Of the total placer gold, the dredges produced 90.6%, the hydraulic nimes 4.5%, the drift mines 2.9%, and the surface or sluicing mines 2%. The three larger and more important dredging fields of the State are at Oroville, Butte County; Folsom, Sacramento County; and Marysville, Yuba County. Dredges are also operated in eight other counties, 5 in Calaveras, 1 in El Dorado, 1 in Merced, 2 in Placer, 3 in Shasta, 3 in Siskiyou, 2 in Stanislaus, and 3 in Trinity. The Yuba County dredges, 13 in number, made the largest output of gold, the value being $3,140,150, an increase of $464,060. Sacramento County with 13 dredges at work made an output of $1,829,478, a decrease of $300,309. In Butte County (including Oroville and "outside" districts) 14 dredges produced $1,210,874 in gold, or $280,192 less than in 1915. This statement shows that $116,441 less gold was obtained in these three districts than in 1915, but the increase in other districts of the state reduced the total decrease in dredge output to $27,238 in 1916, as compared to 1915.

"Of the 28 counties producing gold in 1916 in California, 7 yielded no placer gold and 4 yielded no gold from deep mines. Six counties produced more than $1,000,000 each in gold in 1916 as follows: Nevada, $3,669,878; Amador, $3,660,550; Yuba, $3,167,723; Sacramento, $1,833,855; and Butte, $1,257,231. The leading hydraulic mining county was Trinity; the greatest producer of gold from drift mines was Placer; the largest producer of gold from dredges was Yuba; and the largest producer from surface or sluicing mines was El Dorado. The largest increase ($464,013), in total yield of gold in 1916 as compared with 1915 was in Yuba, which was followed by Nevada with $203,156, Mono with $129,782, Mariposa with $16,141, Siskiyou with $14,591, Placer with $14,081, Stanislaus, Imperial and Humboldt with smaller amounts. Most of the counties showed a decreased yield of gold for 1916, as Sacramento, $297,958; Butte,

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$288,745; Kern, $236,277; Amador, $233,575; Tuolumne, $189,866; Inyo, $186,183; Shasta, $183,963; San Bernardino, $137,154; El Dorado, $39,467; Calaveras, $35,014; Plumas, $34,055; Trinity, Modoc, Fresno, Riverside, Sierra, San Diego, Madera, Lake, and Del Norte with smaller amounts.

* * * * * * * * * *

"From the siliceous ore and old tailings the recovery of gold by methods of treatment in California in 1916 was as follows: By amalgamation, 413,033.24 fine ounces, valued at $8,538,155; by cyanidation, 56,973.95 fine ounces, valued at $1,777,756; by chlorination, 15,979.47 fine ounces, valued at $330,323; concentrates sent to smelters for reduction, gold recovery, 78,033.90 ounces, valued at $1,613,104. Where gold-mining companies have no cyanide or chlorination plants, it is the custom to send the concentrates to smelting plants for reduction, under contracts to pay certain specific prices for this work. The figures given above for cyanidation recovery are approximate only for the reason that the returns received from individual mines do not always segregate the recovery by sources. Some of the mining companies pass the pulp from the amalgamating mills direct through to their cyanide plants, and give their total recovery without accounting for the quantity of gold saved by separate systems of treatment." * * *

The gold production of California for 1916 was distributed, by counties, as follows:

County	Value	County	Value
Amador	$3,660,550	Nevada	$3,669,878
Butte	1,257,231	Placer	428,400
Calaveras	1,356,120	Plumas	133,385
Del Norte	405	Riverside	7,855
El Dorado	361,821	Sacramento	1,833,855
Fresno	69	San Bernardino	279,813
Humboldt	21,279	Shasta	936,885
Imperial	23,338	Sierra	724,256
Inyo	131,722	Siskiyou	441,307
Kern	747,042	Trinity	435,493
Madera	10,306	Tuolumne	868,237
Mariposa	401,718	Yuba	3,167,723
Merced and Stanislaus*	271 616		
Modoc	2,729		
Mono	237,084	Total	$21,410,741

*Combined to conceal output of a single property in each.

Total Gold Production of California.

The following table was compiled by Chas. G. Yale, of the Division of Mineral Resources, U. S. Geological Survey, but for a number of years statistician of the California State Mining Bureau and the U. S. Mint at San Francisco. The authorities chosen for certain periods were: J. D. Whitney, state geologist of California; John Arthur Phillips, author of "Mining and Metallurgy of Gold and Silver" (1867); U. S. Mining Commissioner R. W. Raymond; U. S. Mining Commissioner J. Ross Browne; Wm. P. Blake, Commissioner from California to the Paris Exposition, where he made a report on "Precious Metals" (1867); John J. Valentine, author for many years of the

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annual report on precious metals published by Wells Fargo & Company's Express; and Louis A. Garnett, in the early days manager of the San Francisco refinery, where records of gold receipts and shipments were kept. Mr. Yale obtained other data from the reports of the director of the U. S. Mint and the director of the U. S. Geological Survey. The authorities referred to, who were alive at the time of the original compilation of this table in 1894, were all consulted in person or by letter by Mr. Yale with reference to the correctness of their published data, and the final table quoted was then made up.

The figures since 1904 are those prepared by the U. S. Geological Survey:

Year	Value	Year	Value
1848	$245,301	1884	$13,600,000
1849	10,151,360	1885	12,661,044
1850	41,273,106	1886	14,716,506
1851	75,938,232	1887	13,588,614
1852	81,294,700	1888	12,750,000
1853	67,613,487	1889	11,212,913
1854	69,433,931	1890	12,309,793
1855	55,485,395	1891	12,728,869
1856	57,509,411	1892	12,571,900
1857	43,628,172	1893	12,422,811
1858	46,591,140	1894	13,923,281
1859	45,846,599	1895	15,334,317
1860	44,095,163	1896	17,181,562
1861	41,884,995	1897	15,871,401
1862	38,854,668	1898	15,906,478
1863	23,501,736	1899	15,336,031
1864	24,071,423	1900	15,863,355
1865	17,930,858	1901	16,989,044
1866	17,123,867	1902	16,910,320
1867	18,265,452	1903	16,471,264
1868	17,555,867	1904	19,109,600
1869	18,229,044	1905	19,197,043
1870	17,458,133	1906	18,732,452
1871	17,477,885	1907	16,727,928
1872	15,482,194	1908	18,761,559
1873	15,019,210	1909	20,237,870
1874	17,264,836	1910	19,715,440
1875	16,876,009	1911	19,738,908
1876	15,610,723	1912	19,713,478
1877	16,501,268	1913	20,406,958
1878	18,839,141	1914	20,653,496
1879	19,626,654	1915	22,442,296
1880	20,030,761	1916	21,410,741
1881	19,223,155		
1882	17,146,416	Total	$1,652,594,437
1883	24,316,873		

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IRIDIUM (see under Platinum).

IRON ORE.

Bibliography: State Mineralogist Reports, II, IV, V, X, XII, XIII, XIV. Am. Inst. Min. Eng., Trans. LIII. Min. & Sci. Press, Vol. 115, pp. 112, 117–122. Bulletins 38, 67.

Iron ore to the extent of 3,000 tons, valued at $6,000, was produced in California during the year 1916. It was utilized in the production of pig iron, ferro-manganese, ferro-silicon, and ferro-chrome by electric furnace reduction.

There are considerable deposits of iron ore known in California, notably in Shasta, Madera, Placer, Riverside and San Bernardino counties, but production has so far been limited, on account of our having no economic supply of coking coal. Further developments along the line of electrical smelting, or discoveries making valuable our petroleum fuel, would lead to considerable increase of iron mining in California. For the present, at least, the most feasible possibilities lie in utilizing our iron resources in the preparation of the various alloys such as ferro-chrome, ferro-manganese, ferro-molybdenum, ferro-silicon and ferro-tungsten, by means of the electric furnace. California possesses commercial deposits and is now producing ores of all of the metals just enumerated. In addition to the electric smelting units now in operation, two blast furnace units are at the present writing under construction—one in Shasta County, the other in San Bernardino—and another electric smelter is also proposed.

Total iron ore production in the state, with annual amounts and values, is as follows:

Year	Tons	Value	Year	Tons	Value
1881*	9,273	$79,452	1908		
1882	2,073	17,766	1909	108	$174
1883	11,191	106,540	1910	579	900
1884	4,532	40,983	1911	558	558
1885			1912	2,508	2,508
1886	3,676	19,250	1913	2,343	4,485
1887			1914	1,436	5,128
1893	250	2,000	1915	724	2,584
1894	200	1,500	1916	3,000	6,000
1895					
1907	400	400	Totals	42,851	$290,228

*Productions for the years 1881-1886 (inc.) were reported as "tons of pig iron," (U. S. G. S., Min. Res. 1885), and for the table herewith are calculated to "tons of ore" on the basis of 47.6% Fe as shown by an average of analyses of the ores (State Mineralogist's Report IV, p. 242). This early production of pig iron was from the blast furnaces then in operation at Hotaling in Placer County. Charcoal was used in lieu of coke. Though producing a superior grade of metal, they were obliged finally to close down, as they could not compete with the cheaper English and eastern United States iron brought in by sea to San Francisco.

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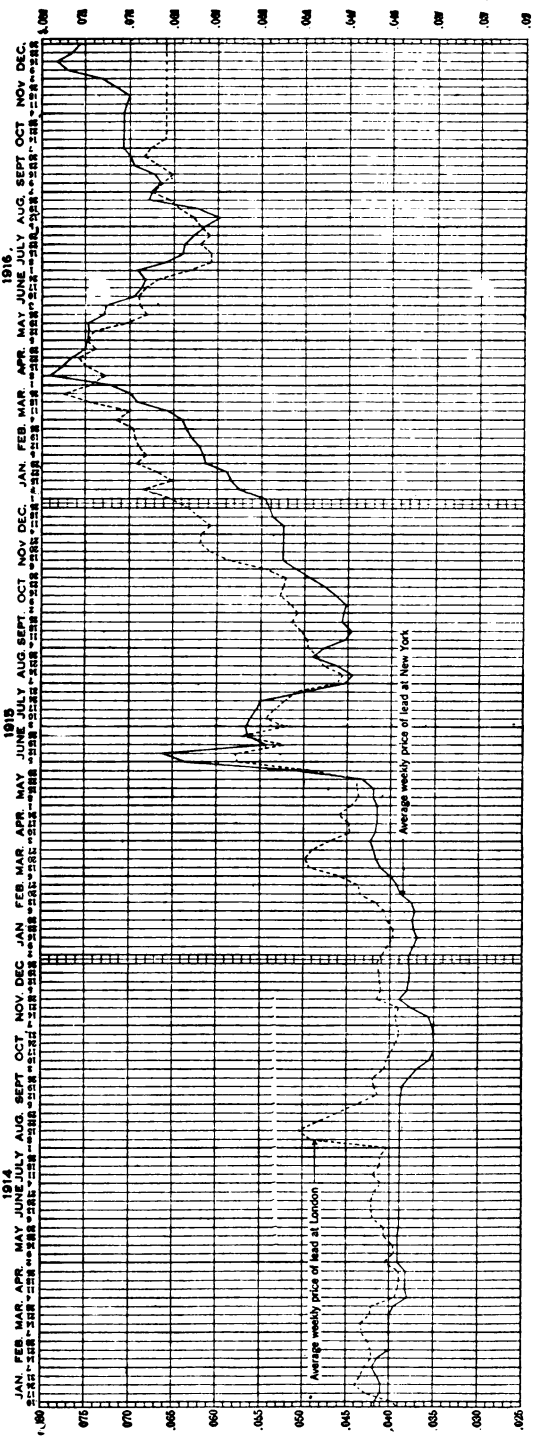

Average weekly price of lead at New York and London, 1914–1916—from U. S. G. S., press bulletin, Apr. 9, 1917.

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LEAD.

Bibliography: State Mineralogist Reports IV, VIII, X.

Lead was produced during 1916, to the extent of 12,392,031 pounds, which at 6.9¢ per pound was valued at $855,049, being an increase of nearly 300% in amount and nearly 400% in value as compared to the previous year. The principal yield comes from Inyo County, followed by San Bernardino, Shasta, and Kern in the order named. The ores are mined, and shipped to smelters. On account of the European war, the price increased from the 3.9¢ per pound average of 1914, to 4.7¢ in 1915 and 6.9¢ in 1916. The fluctuations in the price may be studied from the chart reproduced herewith, from a recent press bulletin of the U. S. Geological Survey.

County returns for 1916, showing amounts and values, were:

County	Pounds	Value	County	Pounds	Value
Calaveras	7,238	$499	San Bernardino	673,801	$46,492
Fresno	668	46	Shasta	478,560	33,021
Inyo	11,185,321	771,787	Tuolumne	873	60
Kern	24,274	1,675	Imperial and Placer*	17,826	1,230
Mariposa	1,857	128			
Nevada	1,036	71	Totals	12,392,031	$855,049
Riverside	350	24			
Sacramento	227	16			

*Combined to conceal output of a single mine in each.

Statistics on lead production in California were first compiled by this Bureau in 1887. Amount and value of the output, annually, with total figures, to date, are given in the following table:

Year	Tons	Value	Year	Tons	Value
1887	580	$52,200	1903	55	$3,960
1888	450	38,250	1904	62	5,270
1889	470	35,720	1905	266	25,083
1890	400	36,000	1906	169	19,307
1891	570	49,020	1907	164	16,690
1892	680	54,400	1908	562	46,663
1893	333	24,975	1909	1,343	144,897
1894	475	28,500	1910	1,508	134,082
1895	796	49,364	1911	701	63,173
1896	646	38,805	1912	685	61,653
1897	298	20,264	1913	1,820	160,202
1898	328	23,907	1914	2,349	183,198
1899	360	30,642	1915	2,398	225,426
1900	520	41,600	1916	6,196	855,049
1901	360	28,820			
1902	175	12,230	Totals	25,719	$2,509,350

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MANGANESE.

Bibliography: State Mineralogist Reports XII, XIII, XIV. Bulletins 38, 67; U. S. G. S., Bull. 427.

In the statistical reports of 1913 and 1914, manganese ore was included in the "industrial materials" list. We have since made a transfer, and now place it under "metals," because by far the greater tonnage of manganese ore is utilized in the preparation of ferro-manganese and employed in the steel industry for its metal content. Though its other uses may be classed as "chemical," the tonnage thus consumed is relatively smaller. Its chemical uses are as a decolorizer or oxidizer in glass manufacture, and as a constituent in electric dry batteries. The chemical uses require a much higher grade of ore than the steel industry. For steel purposes, an iron content is acceptable, but manganese should exceed 40%. Silica should be under 8%, though higher has been taken during the present increased demand. Phosphorus should be under 0.20%. For electric dry cells, the iron content should be under 1.5% Fe_2O_3, and SiO_2, under 6%. For glass making, the manganese should be practically free of iron.

The following will indicate the specifications and prices quoted in May of the curent year 1917, showing that the demand is still strong:

[7]"Manganese prices and specifications, as per the quotations of the Carnegie Steel Co. schedule of prices per ton of 2,240 lb. for domestic manganese ore delivered, freight prepaid, at Pittsburg, Pa., or Chicago, Ill. For ore containing

	Per unit
Above 49% metallic manganese	$1.00
46 to 49% metallic manganese	0.98
43 to 46% metallic manganese	0.95
40 to 43% metallic manganese	0.90

"Prices are based on ore containing not more than 8% silica nor more than 0.2% phosphorus, and are subject to deductions as follows: (1) for each 1% in excess of 8% silica, a deduction of 15¢ per ton, fractions in proportion; (2) for each 0.02% in excess of 0.2% phosphorus, a deduction of 2¢ per unit of manganese per ton, fractions in proportion; (3) ore containing less than 40% manganese, or more than 12% silica, or 0.225% phosphorus, subject to acceptance or refusal at buyer's option; settlements based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken to be deducted from the weight. Prices are subject to change without notice unless specially agreed upon.

"Manganese: The demand for manganese in the East continues strong and the schedule prices remain at $1 per unit or under; 40% has always found ready buyers at comparatively good prices and the market has a very firm tendency. Chemical ore is quoted at 4½¢ to 6¢ per lb. according to grade."

Though the imports of manganese ore from the Caucasus district in Russia have been reduced by the war to practically nothing (about 1% of 1914 figures), the United States is now receiving important shipments from Brazil and India; so that the total imports for 1916 were practically double those of either 1914 or 1915. The increased demand

[7]Min. & Sci. Press, May 26, 1917, p. 751.

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for steel products has increased the necessity for ferro-manganese, which is used largely in the open-hearth process of steel making. This resulted in curtailment of ferro-manganese exports from England, and the resulting shortage in the United States has been met by the greater imports of manganese ore from Brazil especially, and an increased domestic production both of ore and ferro-manganese. These conditions have caused the prices for the ores to range from $12–$30 per ton, f. o. b. rail, California, for the lower grades, to $50–$75 for chemical grades.

Much of the state's 1916 product was utilized in California in making ferro-manganese by electric furnace; besides shipments which were sent east. Some "chemical" ore was also shipped in 1916. For many years the principal producing section has been the Livermore–Tesla district, in Alameda and San Joaquin counties, but exceeded in 1915 by Mendocino and regaining the lead in 1916. Manganese is reported to exist in many localities in the state; but past production, particularly since the discontinuance of the chlorination process in the metallurgy of gold, has been relatively unimportant until the present activity.

The reports to the U. S. Geological Survey indicate that in 1916, California led the other states in manganese production, being "the first year in which a Western State remote from the steel-producing centers has contributed the largest amount of manganese ore. The activity among manganese mines in California is due largely to the market for ores provided by the Noble Electric Steel Co. at Heroult."

The production of manganese ore in California for 1916 amounted to 13,404 tons of all grades, having a total value of $274,601 f. o. b. rail shipping point. It will be noted that this is nearly equal in quantity to the entire previous tonnage, 1887–1915, and about double the value for the same period.

It was distributed by counties as follows:

County	Tons	Value
Alameda	562	$9,005
Mendocino	1,735	43,005
San Joaquin	6,493	115,460
Stanislaus	160	2,400
Amador, Butte, Lake, Nevada, Riverside, San Bernardino, Santa Clara, Shasta, Sonoma, Trinity*	4,454	104,731
Totals	13,404	$274,601

*Combined to conceal output of a single mine in each.

The ore credited to Shasta County in the above tabulation was a low-grade, siliceous material analyzing from 23% to 29% Mn and

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from 19% to 36% SiO_2. It was obtained near Heroult and utilized by the Noble Electric Steel Company in the preparation of silico-manganese, shipments of which were made to Liverpool, England. They have, however, ceased the smelting of this particular product in the electric furnace, as it is stated not to have been profitable.

The production of manganese ore in California annually since 1887 follows:

Year	Tons	Value	Year	Tons	Value
1887	1,000	$9,000	1903	1	$25
1888	1,500	13,500	1904	60	900
1889	53	901	1905		
1890	386	3,176	1906	1	30
1891	705	3,830	1907	1	25
1892	300	3,000	1908	321	5,785
1893	270	4,050	1909	3	75
1894	523	5,512	1910	265	4,235
1895	880	8,200	1911	2	40
1896	518	3,415	1912	22	400
1897	504	4,080	1913		
1898	440	2,102	1914	150	1,500
1899	295	3,165	1915	4,013	49,098
1900	131	1,310	1916	13,404	274,601
1901	425	4.405			
1902	870	7,140	Totals	27,043	$413,500

MOLYBDENUM.

Bibliography: Report XIV; Bulletin 67. U. S. Bur of M., Bulletin 111. Proc. Colo. Sci. Soc., Vol. XI.

Molybdenum, as the metal, is used as an alloy constituent in the steel industry, and in certain forms of electrical apparatus. Included in the latter, is its successful substitution for platinum and platinum-iridium in electric contact making and breaking devices. In alloys it is used similarly to and in conjunction with chromium, cobalt, iron, manganese, nickel, tungsten, and vanadium. The oxides and the ammonium salt have important chemical uses.

The two principal molybdenum minerals are: the sulphide, molybdenite; and wulfenite, lead molybdate, the former furnishing practically the entire commercial output. Molybdenite is found in or associated with acidic igneous rocks, such as the granites and pegmatites. Up to 1916, at least, the chief commercial sources have been New South Wales, Queensland and Norway.

Deposits of disseminated molybdenite are known in several localities in California, and in at least two places it occurs in small masses associated with copper sulphides. For 1916, we are here able to record

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the first commercial shipments of molybdenum ore in California, amounting to 8 tons valued at $9,945, from Inyo and Plumas counties. An increased yield is in prospect for 1917, from several counties, including Inyo, Mono, Plumas, Shasta, and possibly Siskiyou.

NICKEL.

Bibliography: Report XIV. U. S. G. S., Bulletin 640-D.

Nickel occurs in the Friday Copper Mine in the Julian District, San Diego County. The ore is a nickel-bearing pyrrhotite, with some associated chalcopyrite. Some ore was mined during 1915 and 1916 in the course of development work, but was not treated nor disposed of, as they are as yet unable to get any smelter to handle it for them. Nickel ore has also been reported from Siskiyou County, west of Gazelle.

OSMIUM (see under Platinum).

PALLADIUM (see under Platinum).

PLATINUM.

Bibliography: State Mineralogist Reports IV, VIII, IX, XII, XIII, XIV. Bulletins 38, 45, 67.

In California platinum is obtained as a by-product from placer operations for gold. The major portion of it comes from the dredges operating in Butte, Calaveras, Sacramento and Yuba counties, while the hydraulic and surface sluicing mines of Del Norte, Humboldt, Siskiyou and Trinity and the dredges of Merced and Stanislaus yield a smaller amount. Thanks are due to the Division of Mineral Resources, U. S. Geological Survey for coöperation and assistance in collecting the figures presented herewith.

The production for 1916 amounted to 886 ounces of crude platinum—group metals, valued at a total of $42,642. Crude platinum varies considerably in its purity. That marketed during the year 1914,[8] is stated to have averaged 51% platinum, 3% iridium, and 30% iridosmine or osmiridium. Some platinum is also recovered in the electrolytic refining of blister copper. It has been found[9] that blister copper from several smelters in the United States carries from 0.342 oz. to 1.825 oz. platinum and from 0.607 oz. to 4.402 oz. palladium per 100 tons of blister copper treated; that from Iron Mountain, Shasta County, California, yielding 1.320 oz. platinum and 0.607 oz. palladium. Iron in greater or less amount is always alloyed naturally with native platinum, and usually some iridium and osmium.

[8] U. S. G. S., Min. Res., 1914, Pt. I, p. 336.
[9] Trans. Am. Inst. Min. Eng., vol. 47, pp. 217-218, 1913.

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For 1916, the distribution, by counties, was as follows:

County	Ounces	Value
Butte	76	$3,472
Calaveras	54	2,453
Del Norte	2	73
Humboldt	7	296
Sacramento	195	8,892
Trinity	113	5,161
Yuba	314	14,301
Merced, Nevada, Shasta[10], Siskiyou, Stanislaus*	125	7,994
Totals	886	$42,642

Russia has in the past been producing from 90% to 95% of the world's platinum; but, according to U. S. Consular Reports, the yield for 1916 was reduced to one-third of the normal, on account of the "scarcity of labor in the case of hand washings by tributers, and in the case of mechanical dredging plants by the difficulty in obtaining spare parts for dredges"—both, a reflection of war conditions. The price of the metal has consequently risen to over $100 per troy ounce for refined platinum. During 1916, it varied from $90 in January, to $55 in August, $105 December 1st, and closing the year at $82. The miners of California received from $43 to $76 per ounce for their crude platinum, and an average of $45.50, as against $29 to $38 per ounce during 1915.

Next in importance to Russia as a producer of platinum is Colombia. California is the leading producer in the United States. There have been occasional reports of platinum in California being found in vein materials, but as yet no authentic case has come to the notice of the laboratory of the State Mining Bureau. In this connection, however, the recent report[11] of an analysis of chromite from Del Norte County showing 0.04 oz. platinum per ton is of more than passing interest, and apparently reliable. Platinum and chromite are alike in their association with serpentine derived from basic igneous rocks such as peridotite, pyroxenite and dunite. The two have been found intergrown in dunite on the Tulameen River in British Columbia.

Besides, its well-known uses in jewelry, dentistry and for chemical ware, an important industrial development of recent years, employs platinum in the "contact process" of manufacturing concentrated

[10]Yield of Shasta County is refined metals of the platinum group obtained from blister copper in the electrolytic refinery.
[11]Min. & Sci. Press, June 30, 1917, p. 929.
*Combined to conceal output of a single operator in each.

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sulphuric acid. It is also necessary for certain delicate parts of the ignition systems in automobiles, motor boats, and aeroplanes.

Because of the effect of the limited supply and the high prices of platinum on the present industrial situation, the jewelers' and dentists' associations have voluntarily agreed to curtail consumption of this metal so far as possible. Experiments are being made to find alloys which can replace platinum for dishes and crucibles in analytical work, but so far with only slight success.

The annual production and value since 1887, have been as follows:

Year	Ounces	Value	Year	Ounces	Value
1887	100	$400	1903	70	$1,052
1888	500	2,000	1904	123	1,849
1889	500	2,000	1905	200	3,320
1890	600	2,500	1906	91	1,647
1891	100	500	1907	300	6,255
1892	80	440	1908	706	13,414
1893	75	517	1909	416	10,400
1894	100	600	1910	337	8,386
1895	150	900	1911	511	14,873
1896	162	944	1912	603	19,731
1897	150	900	1913	368	17,738
1898	300	1,800	1914	463	14,816
1899	300	1,800	1915	667	21,149
1900	400	2,500	1916	886	42,642
1901	250	3,200			
1902	39	468	Totals	9,547	$198,741

QUICKSILVER.

Bibliography: State Mineralogist Reports IV, X, XII, XIII, XIV; Bulletin 27. U. S. G. S., Monograph XIII.

Quicksilver was produced in 14 counties in 1916, to the amount of 21,427 flasks, valued at $2,003,425, which is a 50% increase in number of flasks and nearly 90% in value over the year 1915. The European war has caused a considerable rise in the price of quicksilver, due to the prohibition of exports from Austria and Italy, and the retention of the Spanish output in England, to say nothing of its increased use in munitions manufacture. Immediate steps were taken by many to reopen old quicksilver properties which had been idle for many years. A total of approximately 1219 men were employed in the quicksilver mines of California in 1916, an increase of about 500 over the preceding year.

Prices.

The following table of monthly San Francisco quotations per flask of 75 pounds, will indicate the decided change in the status of quicksilver during the year 1916, as compared with the pre-war price of about $37 per flask. As San Francisco is the primary domestic market

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for quicksilver, the average yearly quotations on this market have previously been used by the State Mining Bureau (and the U. S. Geological Survey, also) in calculating the value of the state's output of this metal. The 1914 figure was $49.05 per flask. However, because in 1915 and 1916 there was considerable speculation in quicksilver by parties other than the actual producers, and the price changes were often rapid, so that quotations did not always mean sales, we have in these two years taken for the average value the average actual sales as reported to us by the producers. This gives us an average value of $81.52 per flask for the year 1915, instead of the $85.80 average of quotations, and for 1916, $93.50 instead of $125.89.

San Francisco Quotations of Quicksilver, 1916.

Month	Average price	Month	Average price
January	$222 00	July	$81 20
February	295 00	August	74 50
March	219 00	September	75 00
April	141 60	October	78 20
May	90 00	November	79 50
June	74 70	December	80 00

Recent consular reports[12] indicate that the output of the famous mines of Almaden, Spain, has decreased somewhat, and the expense of operation increased. These mines are owned by the government and operated by contractors using convict labor. Bids have been called for by the Minister of the Treasury for new leases for working the deposits, and additional capital expenditure and exploration work will be required. The cost of production of quicksilver is stated to have increased from $8.29 a flask in 1900 to $15.22 in 1915.

For two or three years previous to the outbreak of the European war, our normal peace-times consumption of quicksilver in the United States was approximately 25,000 flasks annually; and our domestic production had fallen below 20,000 flasks per year. Of this 25,000-flask peace-time consumption, nearly 50% went into the manufacture of fulminate for explosive caps for mining, quarrying, and sporting arms ammunition as well as military ammunition. Our domestic production being inadequate, partly because of the low price and the lower average tenor of the ores mined, necessitated the importation of some 5,000 flasks annually. The enormous increase in munitions manufacture due to the war has, of course, raised our requirements correspondingly.

[12]U. S. Commerce Reports, No. 298, Dec. 20, 1916, p. 1079; Annual Series, No. 15B. June 22, 1917, p. 33.

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The import duty of 10% *ad valorum* is not sufficient to protect our American miners against the competition of the convict-operated mines of Spain where quicksilver can be produced for as low as $8–$15 per flask, as noted above. The duty should be at least 25% *ad valorum* to give us proper protection. The present improvement in the price has increased the number of operating properties in California. Lower grade ores are being worked; and new methods of ore dressing and reduction are being tried.

From a consideration of the above facts and other circumstances of the situation, it would appear that the present economic level for the price of quicksilver should be around $100 per flask. This condition seems likely to continue at least as long as the war lasts.

A shipment of 300 flasks of quicksilver from the New Idria Mine, San Benito County.

Uses.

The important uses of quicksilver are the recovery of gold and silver by amalgamation, and in the manufacture of fulminate for explosive caps, of drugs, of electric appliances, and of scientific apparatus. By far the greatest consumption is in the first two mentioned.

Quicksilver is an absolutely essential element from a military standpoint, as there has not yet been produced a commercial substitute for it in the manufacture of fulminating caps for explosives. However, in

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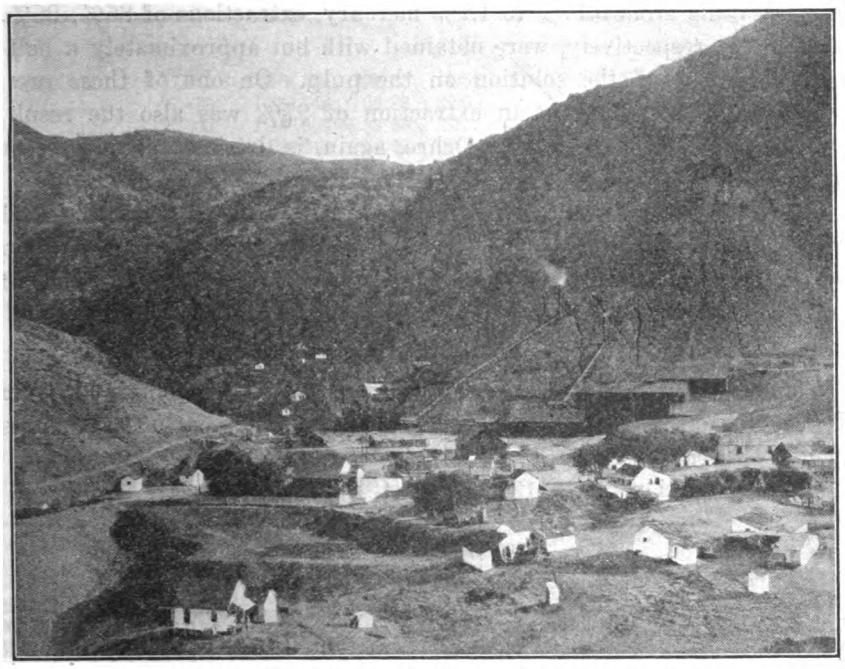
order to reduce consumption of the fulminate, some potassium chlorate, picric acid, trinitro-toluol, or tetranitro-methalamine is at present being mixed with it.

Concentration of Quicksilver Ores.

For the above reason, and the fact that California has been, and still is, producing from 70% to 80% of the quicksilver yield of the United States, the investigation of the possibilities of concentration for quicksilver ores, which has been under way for the past two years by the author is particularly opportune.



The New Idria Quicksilver Mine, San Benito County, California. The largest quicksilver producer in the United States.

In the Bureau's investigation a wide variety of ores has been tested by water concentration, flotation with oils, and a wet method by solution with an alkaline sulphide. Each of these methods has shown some ores particularly amenable to it.

High recoveries were obtained by water concentration on tables, with certain friable ores in which the cinnabar is distinctly crystalline. Good results were obtained by tables on an ore carrying native quicksilver. In those pulps carrying a cinnabar slime, either from "paint" ores or by reason of having to crush fine to release the sulphide, the extraction by tables is low. The slimed cinnabar can, in many cases, be economically won by flotation, provided there are no interfering

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elements in the gangue. Ochre appears to be particularly difficult to overcome, largely on account of its colloidal nature. One very interesting development was the verification of information that had come to the author of a selective oil combination for ores carrying objectionable amounts of pyrite. A mixture of crude wood turpentine and a crude asphaltic-base petroleum gave a higher grade concentrate with visibly less pyrite in it than any single oil used—in the case of one such ore tested.

In the matter of solution by an alkaline sulphide ($Na_2S+NaOH$) some rather astonishing results were obtained. On four widely variant ores, assaying from 0.14% to 1.7% mercury, extractions of 86%, 96%, 97%, 97%, respectively, were obtained with but approximately a half-hour's contact of the solution on the pulp. On one of these ores, assaying 0.31% mercury, an extraction of 97% was also the result, *with but 15 minutes contact.* Ochre, again, is detrimental, if present in excess.

As announced in our Press Bulletin, No. 40, May 15, 1917, the final report on these investigations will form a portion of the new bulletin on California's Quicksilver Resources, which is expected to be printed and ready for distribution before the end of the present year.

Production.

Though some domestic yield of this metal is now obtained from Texas, Nevada, Arizona, and Oregon, the bulk of the output still comes from California.

The distribution of the 1916 product, by counties, was:

County	Amount, flasks	Value
Colusa	285	$26,648
Lake	1,139	106,496
Napa	1,150	107,525
San Benito	11,110	1,032,156
San Luis Obispo	1,227	114,724
Santa Clara	4,016	375,496
Solano	660	61,710
Sonoma	1,039	97,146
Kern, Kings, Monterey, Santa Barbara, Stanislaus and Trinity*	801	81,524
Totals	21,427	$2,003,425

*Combined to conceal output of a single mine in each.

Total Quicksilver Production of California.

Total amount and value of the quicksilver production of California, as given in available records, is shown in the following tabulation. Though the New Almaden mine in Santa Clara County was first worked in 1824, and has been in practically continuous operation since

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1846 (though the yield was small the first two years), there are no available data on the output earlier than 1850. Previous to June, 1904, a "flask" of quicksilver contained 76½ pounds, but since that date 75 pounds. In compiling this table the following sources of information were used: For 1850–1883, table by J. B. Randol, in Report of State Mineralogist, IV, p. 336; 1883–1893, U. S. Geological Survey reports; 1894 to date, statistical bulletins of the State Mining Bureau; also State Mining Bureau, Bulletin 27, "Quicksilver Resources of California," 1908, p. 10:

Year	Flasks	Value	Average price per flask	Year	Flasks	Value	Average price per flask
1850	7,723	$768,052	$99 45	1885	32,073	$986,245	$30 75
1851	27,779	1,859,248	66 93	1886	29,981	1,064,326	35 50
1852	20,000	1,166,600	58 33	1887	33,760	1,430,749	42 38
1853	22,284	1,235,648	55 45	1888	33,250	1,413,125	42 50
1854	30,004	1,663,722	55 45	1889	26,464	1,190,880	45 00
1855	33,000	1,767,150	53 55	1890	22,926	1,203,615	52 50
1856	30,000	1,549,500	51 65	1891	22,904	1,036,406	45 25
1857	28,204	1,374,381	48 73	1892	27,993	1,139,595	40 71
1858	31,000	1,482,730	47 83	1893	30,164	1,108,527	36 75
1859	13,000	820,690	63 13	1894	30,416	934,000	30 70
1860	10,000	535,500	53 55	1895	36,104	1,337,131	37 04
1861	35,000	1,471,750	42 05	1896	30,765	1,075,449	34 96
1862	42,000	1,526,700	36 35	1897	26,691	993,445	37 28
1863	40,531	1,705,544	42 08	1898	31,092	1,188,626	38 23
1864	47,489	2,179,745	45 90	1899	29,454	1,405,045	47 70
1865	53,000	2,432,700	45 90	1900	26,317	1,182,786	44 94
1866	46,550	2,473,202	53 13	1901	26,720	1,285,014	48 46
1867	47,000	2,157,300	45 90	1902	29,552	1,276,524	43 20
1868	47,728	2,190,715	45 90	1903	32,094	1,335,954	42 25
1869	33,811	1,551,925	45 90	1904	*28,876	1,086,323	37 62
1870	30,077	1,725,818	57 38	1905	24,655	886,061	35 94
1871	31,686	1,999,387	63 10	1906	19,516	712,334	36 50
1872	31,621	2,084,773	65 93	1907	17,379	663,178	38 16
1873	27,642	2,220,482	80 33	1908	18,039	763,520	42 33
1874	27,756	2,919,376	105 18	1909	16,217	773,788	47 71
1875	50,250	4,228,538	84 15	1910	17,665	799,002	45 23
1876	75,074	3,303,256	44 00	1911	19,109	879,205	46 01
1877	79,396	2,961,471	37 30	1912	20,600	866,024	42 04
1878	63,880	2,101,652	32 90	1913	15,661	630,042	40 23
1879	73,684	2,194,674	29 85	1914	11,373	557,846	49 05
1880	59,926	1,857,706	31 00	1915	14,199	1,157,449	81 52
1881	60,851	1,815,185	29 83	1916	21,427	2,003,425	93 50
1882	52,732	1,488,624	28 23				
1883	46,725	1,343,344	28 75	Totals	2,113,346	$99,596,094	
1884	31,913	973,347	30 50				

*Flasks of 75 lbs. since June, 1904; of 76½ lbs. previously.

SILVER.

Bibliography: State Mineralogist Reports IV, VIII, XII, XIII, XIV. Bulletin 67.

Silver in California is produced largely as a by-product from its association with copper, lead, zinc and gold ores. As explained under

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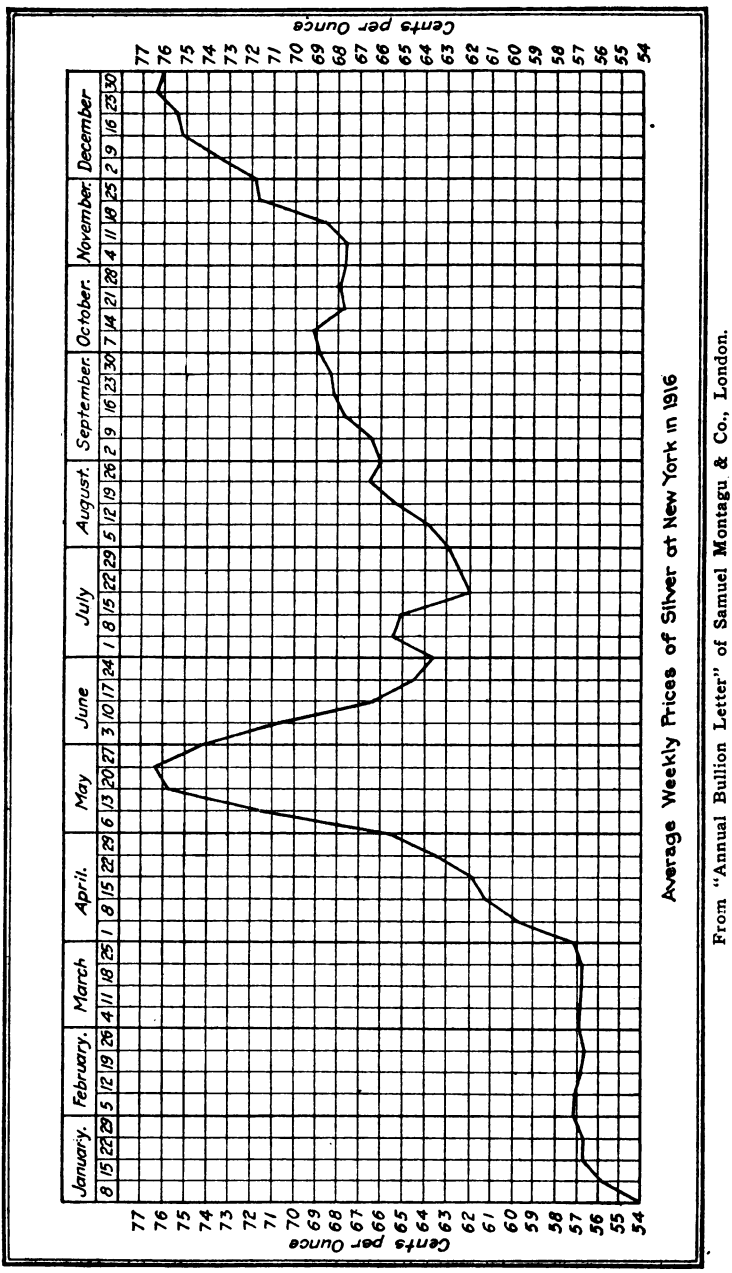

From "Annual Bullion Letter" of Samuel Montagu & Co., London.

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the heading of Gold, the following figures are those of the U. S. Geological Survey. The average price of silver during 1916 was 65.8¢ per ounce at New York, as compared with 54.8¢ in 1914, and 50.7¢ in 1915. During 1916, the monthly average price ranged between the extremes of 54¢ in January and 75¢ in May. The current year, 1917, is so far showing still higher figures.

"The mine yield of silver in California in 1916 was 2,534,743 fine ounces, valued at $1,667,861, an increase in quantity of 893,855 ounces, and in value of $835,931. The larger portion of the output, 2,303,655 ounces, valued at $1,515,805, was derived from crude smelting ores. Siliceous ores milled and smelted, yielded 171,600 fine ounces, valued at $112,913. The largest output of silver came, as usual, from Shasta County, which produced from copper ores, 1,679,455 ounces, valued at $1,105,081; from siliceous ores, 14,644 ounces, valued at $9,636; and from placers, 1,146 fine ounces, valued at $754—a total yield from the county in silver of 1,695,245 ounces, valued at $1,115,471. In 1915 the county produced 906,441 ounces, valued at $459,566. Inyo County followed Shasta in yield of silver, the output being 353,254 ounces, valued at $232,441, an increase as compared with 1915 of 100,997 ounces in quantity and of $104,547 in value. The total silver derived from deep mines of all classes in California in 1916 was 2,534,743 ounces, valued at $1,667,861. The silver obtained with gold in placer mining in the State in 1916 was 29,611 ounces, valued at $19,484. The largest producer of placer silver was Yuba County—9,015 ounces, valued at $5,932.

"With the steady advance of silver in value has come a reopening of some old silver and silver-lead mines. Silver derived from purely silver ores in 1916 amounted to 7,599 fine ounces, valued at $5,000. From 31,127 tons of silver-lead ores there was derived 323,339 ounces of silver, valued at $212,757, as well as $32,516 in gold. From 16,136 tons of lead ore was obtained 2,129 ounces of silver valued at $1,401; and from 29,079 tons of zinc ore the silver yield was 60,293 ounces of silver, valued at $39,673.

* * * * * * * * * * *

"From the siliceous ore and old tailings treated in California in 1916 the recovery of silver by amalgamation was 94,008 fine ounces, valued at $61,857; by cyanidation, 75,369 ounces, valued at $49,593; by chlorination, 634 ounces, valued at $417; and from concentrates sent to smelters, 61,077 fine ounces, valued at $40,189. From smelting ores silver amounting to 2,303,655 fine ounces was recovered, valued at $1,515,805. The above figures do not include the comparatively small quantity of silver recovered with the gold in placer mining operations."

The distribution of the 1916 silver yield, by counties, was as follows:

County	Value	County	Value
Amador	$18,705	Nevada	$35,741
Butte	3,332	Placer	24,928
Calaveras	83,643	Plumas	46,542
Del Norte	2	Riverside	338
El Dorado	1,496	Sacramento	3,578
Fresno	69	San Bernardino	67,146
Humboldt	55	Shasta	1,115,471
Imperial	155	Sierra	3,291
Inyo	232,441	Siskiyou	2,312
Kern	8,745	Trinity	7,591
Madera	1,772	Tuolumne	17,039
Mariposa	2,680	Yuba	5,934
Merced and Stanislaus*	643		
Modoc	90	Total	$1,687,345
Mono	3,606		

*Combined to conceal output of a single property in each.

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The value of the silver produced in California each year since 1887, is as follows:

Year	Value	Year	Value
1887	$1,632,008	1903	$517,444
1888	1,700,000	1904	873,525
1889	754,793	1905	678,494
1890	1,060,613	1906	817,830
1891	953,157	1907	751,646
1892	463,602	1908	873,057
1893	537,157	1909	1,091,092
1894	297,332	1910	993,646
1895	599,789	1911	673,336
1896	422,463	1912	799,584
1897	452,789	1913	832,553
1898	414,055	1914	813,938
1899	504,012	1915	851,129
1900	1,510,344	1916	1,687,345
1901	1,229,356		
1902	616,412	Total	$25,402,496

TIN.

Bibliography: Bulletin 67, "Cassiterite."

Tin is not at present produced in California; but during 1891–1892, there was some output from a small deposit near Corona, in Riverside County, as tabulated below. Small quantities of stream tin have been found in some of the placer workings in northern California, but never in paying amounts.

In 1916 two new occurrences were noted in northern San Diego County. Crystals of cassiterite were found there, associated with blue tourmaline crystals, amblygonite and beryl. No commercial quantity has been developed, only small pockets having been taken out, as yet; but the prospect is an interesting one.

The principal source of the world's supply of tin is the Straits Settlements on the Malay Peninsula, followed in second rank by Bolivia. Siam, Burma and Cornwall are also important sources. A measurable amount of the metal is also recovered by de-tinning scrap and old cans.

Total output of tin in California:

Year	Pounds	Value
1891	125,289	$27,564
1892	126,000	32,400
Totals	251,289	$59,964

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TUNGSTEN.

Bibliography: Report on San Bernardino County, 1917; Bulletins 38, 67. U. S. G. S. Bull. 652. Proc. Colo. Sci. Soc., Vol. XI.

The metal, tungsten, is used mainly in the steel industry and in the manufacture of electrical appliances, including the well-known tungsten filament lamps. Because of its resistance to corrosion by acids, it is valuable in making certain forms of chemical apparatus. Its employment in tool steel alloys, permits the operation of cutting tools, such as in lathe work, at a speed and temperature at which carbon steel would lose its temper—hence the name "high-speed" steels for these tungsten alloys. As made in the United States, tungsten forms 13% to 20% of such steels. Some chromium, nickel, cobalt, or vanadium are sometimes also included.

Tungsten is introduced into the molten steel charge, either as the powdered metal or as ferro-tungsten (containing 50%–85% tungsten). The specific gravity of the pure metal, 19.3–21.4, is exceeded only by platinum, 21.5; iridium, 22.4; and osmium, 22.5. Its melting point is 3,267°C. (5,913°F.), being higher than any other known metal. Though millions of tungsten filament lamps are now made, the wires are so fine that the metal they contain represents but a few tons of tungsten concentrates annually.

Tungsten ore is produced in California principally in the Atolia-Randsburg district in San Bernardino and Kern counties, with small amounts coming from Nevada County and from the district near Goffs, in eastern San Bernardino. Most of the California tungsten ore is scheelite (calcium tungstate), though wolframite (iron-manganese tungstate) and hübnerite (manganese tungstate) also occur. The deposits at Atolia are the largest and most productive scheelite deposits known,[13] and the output has in some years equaled or exceeded that of ferberite (iron tungstate) from Boulder County, Colorado. It is interesting in this connection to note that, in practically all other tungsten producing districts of the world, wolframite is the important constituent. Burma, the largest producer, reports a yield of approximately 2,500 tons of wolframite concentrates for 1916, most of which was obtained from placers, in part associated with cassiterite (tin oxide).

The value of the ore is based upon the content of tungstic trioxide (WO_3), and quotations are commonly made per unit (each 1%) of WO_3 present.

[13] U. S. G. S., Bull 652, p. 32.

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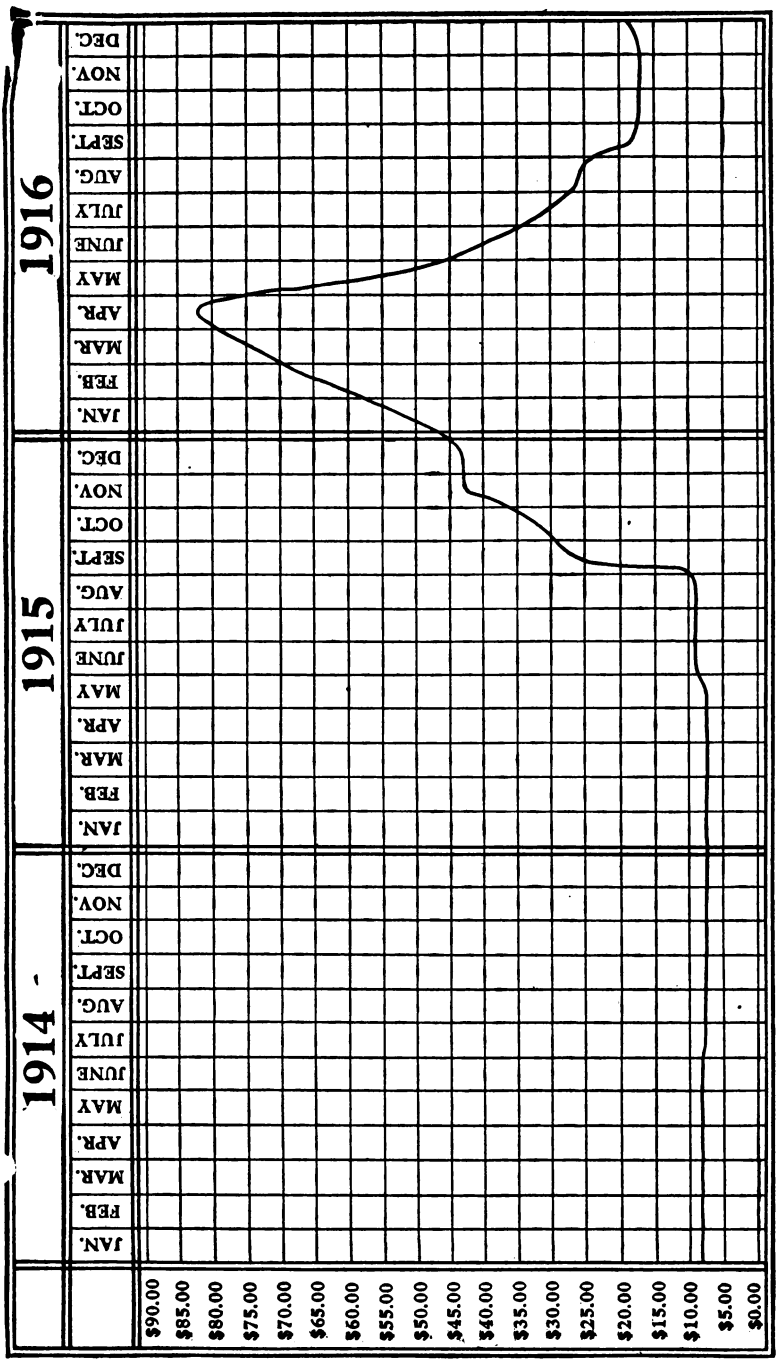

THE TUNGSTEN PEAK OF NINETEEN FIFTEEN-SIXTEEN.

Electrotype by courtesy of the Foote Mineral Company, Philadelphia, Pa.

In plotting the above curve, published quotations in the Eastern mining journals are used from June, 1915, to December, 1916. However, from January, 1914, to May, 1915, only Western published quotations appeared. The Western are here advanced about 10% to approximately include transportation to the East. The figures are the average of all quotations available in each month. Prices are understood to be for ore or concentrates guaranteed to contain 60% or more tungsten trioxide (WO_3), and are per unit (1%, or 20 lbs.) of WO_3 per net ton.

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In 1916 there were marketed 2,270 tons of high-grade ore and concentrates, valued at $4,571,521, which is more than double the tonnage and four and one-half times the value of the 1915 output. The tonnages here shown are re-calculated to a basis of 60% WO_3, the materials reported varying from ore assaying 2% to concentrates running as high as 75%. Most of the concentrates ranged about 65%. Previous to 1915, a single company produced almost all of California's tungsten. During the latter part of 1915, and the early months of 1916, because of the high prices prevailing, prospecting was much stimulated, and the known tungsten-bearing areas have been considerably extended both in San Bernardino and Kern counties. The accompanying chart, reproduced by courtesy of the Foote Mineral Co., Philadelphia, Pa., shows the rapid change in status during that period. Shipments were also made from mines opened up in the Clark Mountain and New York Mountains districts in eastern San Bernardino County. In these latter areas, wolframite and hübnerite are the principal ores, with some scheelite, while at Atolia it is scheelite only. Scheelite ore is also being extracted in Inyo County near Bishop, and two concentrating mills are in operation with a third under construction. The Nevada County ore is also scheelite.

Distribution of the 1916 output was as follows:

County	Tons	Value
Kern	193	$482,387
San Bernardino	1,921	3,915,434
Inyo and Nevada*	156	173,700
Totals	2,270	$4,571,521

*Combined to conceal output of a single mine in Nevada County.

The annual value of tungsten produced in California since the inception of the industry is given herewith:

Year	Value	Year	Value
1905	$18,800	1912	$206,000
1906	189,100	1913	234,673
1907	120,587	1914	180,575
1908	37,750	1915	1.005,467
1909	190,500	1916	4,571,521
1910	208,245		
1911	127,796	Total	$7,090,924

VANADIUM.

Bibliography: Bulletin 67. Proc. Colo. Sci. Soc., Vol. XI. U. S. Bur. of Mines, Bulletin 104.

No commercial production of vanadium has as yet been made in California. Occurrences of this metal have been found at Camp Signal,

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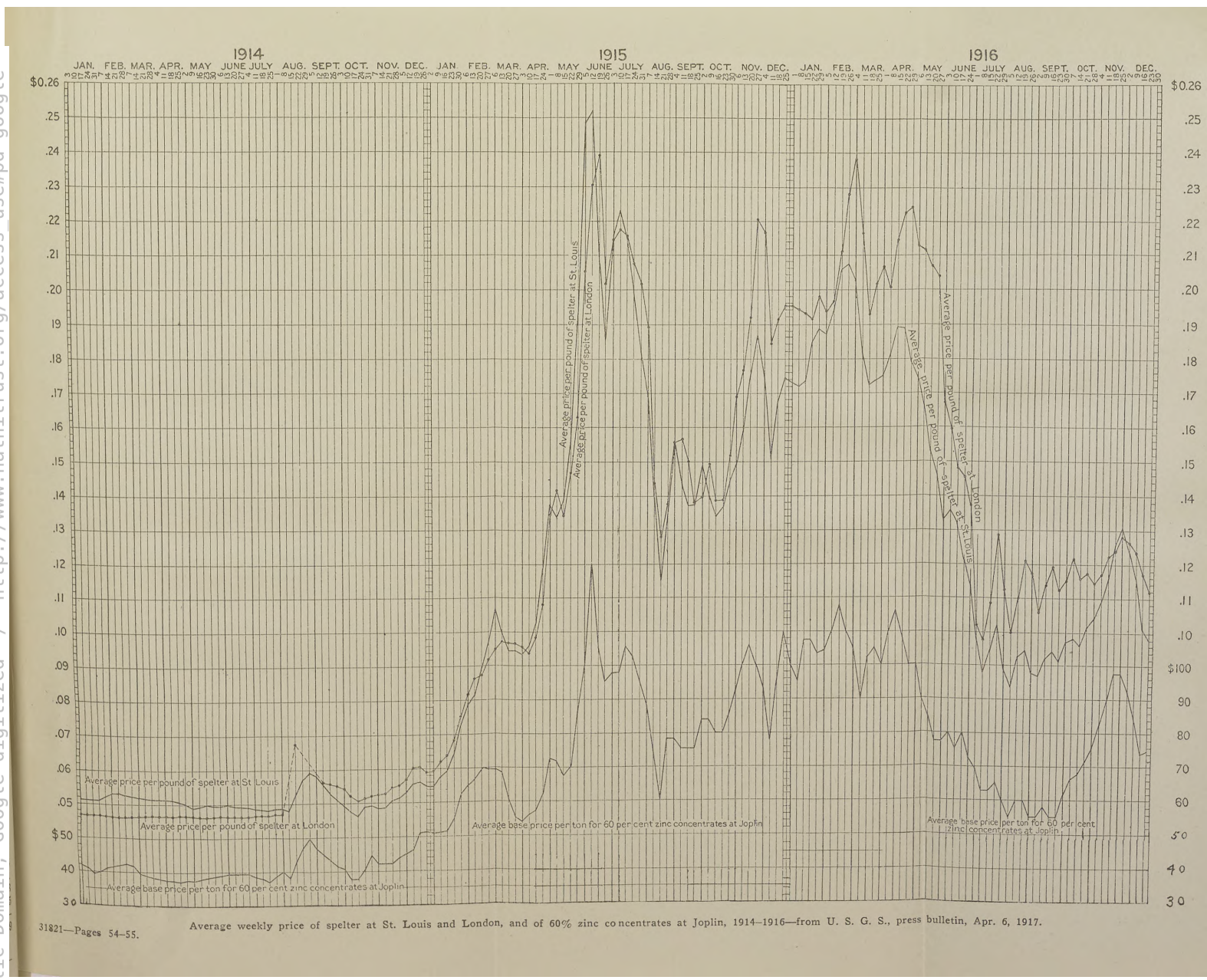

31821—Pages 54–55.

Average weekly price of spelter at St. Louis and London, and of 60% zinc concentrates at Joplin, 1914–1916—from U. S. G. S., press bulletin, Apr. 6, 1917.

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The following table gives the comparative figures for the value of structural materials produced in California during the years 1915 and 1916:

Substance	1915		1916		Increase + Decrease — Value
	Amount	Value	Amount	Value	
Bituminous rock	17,789 tons	$61,468	19,449 tons	$63,561	$5,093+
Brick and tile	180,538 M.	1,678,756	206,960 M.	2,096,570	417,814+
Cement	4,918,275 bbls.	6,044,950	5,299,507 bbls.	6,210,293	165,343+
Chromite	3,725 tons	38,044	48,943 tons	717,244	679,200+
Granite		227,928		535,339	307,411+
Lime	356,534 bbls.	286,304	493,635 bbls.	390,475	104,171+
Magnesite	30,721 tons	283,461	154,052 tons	1,311,893	1,028,432+
Marble	22,186 cu. ft.	41,518	25,954 cu. ft.	50,280	8,762+
Sandstone	63,350 cu. ft.	8,438	17,270 cu. ft.	10,271	1,833+
Slate	1,000 squares	5,000			5,000—
Miscellaneous stone		4,783,180		4,171,519	611,661—
Totals		$13,459,047		$15,560,445	
Net increase					$2,101,398+

ASPHALT.

Bibliography: State Mineralogist Reports VII, X, XII, XIII, XIV. Bulletins 16 and 32.

Asphalt was for a number of years accounted for in reports by the State Mining Bureau, because in the early days of the oil industry, considerable asphalt was produced from outcroppings of oil sand, and was a separate industry from the production of oil itself. However, at the present time most of the asphalt comes from the oil refineries, which produce a better and more uniform grade; hence its value is not now included in the mineral total, as to do so would be a partial duplication of the crude petroleum figures. Such natural asphalt as is at present mined is in the form of bituminous sandstones, and is recorded under that designation.

The production of refinery asphalt from 16 refineries during 1916 was approximately 258,000 tons, valued at $1,959,000; as compared with 166,941 tons, worth $1,363,207 for 1915. California leads all other states of the Union in such production, as her crude oils are almost entirely of asphaltic base.

BITUMINOUS ROCK.

Bibliography: State Mineralogist Reports XII, XIII.

Bituminous rock is used in a number of places, principally for road dressing; but the manufacture of asphalt at the oil refineries has almost eliminated the industry of mining bituminous rock. The production during 1916 from one quarry each in Santa Cruz, San Luis Obispo and Santa Barbara counties was 19,449 tons, valued at $66,561, compared with 17,789 tons and $61,468 in 1915.

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The following tabulation shows the total amount and value of bituminous rock quarried and sold in California, from the records compiled by the State Mining Bureau, annually since 1887:

Year	Tons	Value	Year	Tons	Value
1887	36,000	$160,000	1903	21,944	$53,106
1888	50,000	257,000	1904	45,280	175,680
1889	40,000	170,000	1905	24,753	60,436
1890	40,000	170,000	1906	16,077	45,204
1891	39,962	154,164	1907	24,122	72,835
1892	24,000	72,000	1908	30,718	109,818
1893	32,000	192,036	1909	34,123	116,436
1894	31,214	115,193	1910	87,547	165,711
1895	38,921	121,586	1911	75,125	117,279
1896	49,456	122,500	1912	44,073	87,467
1897	45,470	128,173	1913	37,541	78,479
1898	46,836	137,575	1914	66,119	166,618
1899	40,321	116,097	1915	17,789	61,468
1900	25,306	71,495	1916	19,449	66,561
1901	24,052	66,354			
1902	33,490	43,411	Totals	1,141,688	$3,474,682

BRICK and TILE.

Bibliography: Report XIV. Bulletin 38.

As would be expected in a state with diversified and widespread mineral resources, a great variety of brick is annually produced in California, including common, fire, pressed, glazed, sand-lime, and others. As far as possible the different kinds have been segregated in the following tabulation. We also include under this heading the various forms of hollow building "tile" or blocks, instead of under industrial pottery clays as in earlier reports:

According to Bulletin No. 38, issued by the California State Mining Bureau, the following analyses show the average and the maximum and minimum of the ingredients commonly occurring in brick clays. A clay in which the percentage of any one or more of the ingredients mentioned is much above the maximum given or below the minimum will prove an inferior, if not worthless, clay for even common brick.

Chemical Analyses of Common Brick Clays.

	Average, per cent	Minimum, per cent	Maximum, per cent
Silica (SiO_2), combined	15.0	12.0	30.0
Silica sand	55.0	20.0	60.0
Alumina (Al_2O_3)	14.0	11.0	25.0
Water (H_2O), combined	4.0	3.0	9.0
Water moisture	2.0	0.0	6.0
Iron oxide (Fe_2O_3)	4.0	2.5	8.0
Lime (CaO)	1.5	0.5	7.0
Magnesia (MgO)	1.5	0.3	7.0
Alkalies (K_2O, Na_2O)	3.5	2.0	7.0

The detailed figures of brick production for 1916, by counties, are as follows:

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Brick Production for 1916, by Counties.

County	Common		Fire		Glazed, pressed, fancy, vitrified		Miscellaneous brick and building tile		Totals	
	Amount M	Value	Amount M	Value	Amount M	Value	Amount M	Value	Amount M	Value
Alameda	14,360	$115,650	2,144	$57,545	6,850	$132,898	197	$9,848	23,551	$315,941
Contra Costa	14,272	108,485			2,112	35,799			16,384	144,284
Kern	3,177	23,824							3,177	23,824
Los Angeles	69,605	357,144	5,806	182,302	[1]4,514	130,390	2,080	91,076	82,005	760,912
Orange	1,186	8,300							1,186	8,300
Placer							840	25,000	840	25,000
Riverside			830	21,572					830	21,572
Sacramento	8,061	64,515			[2]394	5,900	390	19,500	8,845	89,915
San Diego	3,023	21,583					261	13,038	3,284	34,621
San Luis Obispo	4,050	40,500							4,050	40,500
San Mateo							52	2,628	52	2,628
Santa Clara	13,100	82,800							13,100	82,800
Tulare	6,300	46,500					30	2,000	6,330	48,500
Fresno, Humboldt, Imperial, Marin, Mendocino, Riverside, San Bernardino, San Joaquin, Santa Barbara, Shasta, Stanislaus, Tehama, Ventura	31,507	208,892								
Amador, Contra Costa, Placer, Sacramento, San Diego, San Joaquin, San Mateo			9,969	228,841						
Placer, Riverside, San Luis Obispo, San Mateo					1,850	60,040			43,326	497,773
Totals	168,641	$1,078,193	18,749	$490,260	15,720	$365,027	3,850	$163,090	206,960	$2,096,570

[1]Includes patent radial interlocking sewer brick; also special sewer blocks.
[2]Includes sand-lime brick.

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Record of brick production in the state has been kept since 1893 by this Bureau. The annual and total figures since that date, for amount and value, are given in the following table:

Year	Thousands	Value	Year	Thousands	Value
1893	103,900	$801,750	1906	277,762	$2,538,848
1894	81,675	457,125	1907	362,167	3,438,951
1895	131,772	672,360	1908	332,872	2,506,495
1896	24,000	524,740	1909	333,846	3,059,929
1897	97,468	563,240	1910	340,883	2,934,731
1898	100,102	571,362	1911	327,474	2,638,121
1899	125,950	754,730	1912	337,233	2,940,290
1900	137,191	905,210	1913	358,754	2,915,350
1901	130.766	860,488	1914	270,791	2,288,227
1902	169,851	1,306,215	1915	180,538	1,678,756
1903	214,403	1,999,546	1916	206,960	2,096,570
1904	281,750	1,994,740			
1905	286,618	2,273,786	Totals	5,214,729	$42,721,560

CEMENT.

Bibliography: State Mineralogist Reports VIII, IX, XII, XIV. Bulletin 38.

Cement is one of the most important structural materials in the output of the state. During 1916 there was produced a total of 5,299,507 barrels, valued at $6,210,293. This output comes from nine operating plants in seven counties, employing approximately 2,500 men. The enlargement of this industry, of course, depends upon the growth of surrounding communities, and a summary of the lime and clay deposits of the state shows that considerable enlargement is quite possible.

The cement industry is so centralized that it is impossible to apportion the production to the counties in which plants are located without making private business public. With the exception of San Bernardino, no county has more than one cement plant. The three operating plants in San Bernardino County, in 1916, made a total of 1,036,000 barrels, valued at $1,246,000; the balance coming from a single plant in each of the following counties: Contra Costa, Kern, Napa, Riverside, Santa Cruz and Solano.

"Portland" cement was first commercially produced in the state in 1891; though in 1860 and for several years following, a natural hydraulic cement from Benicia was utilized in building operations in San Francisco. While the total figures are not of the same magnitude as those for gold and petroleum, the growth of the industry has been more than rapid, and a comparison of the annual figures representing the output since the inception of the industry is of interest.

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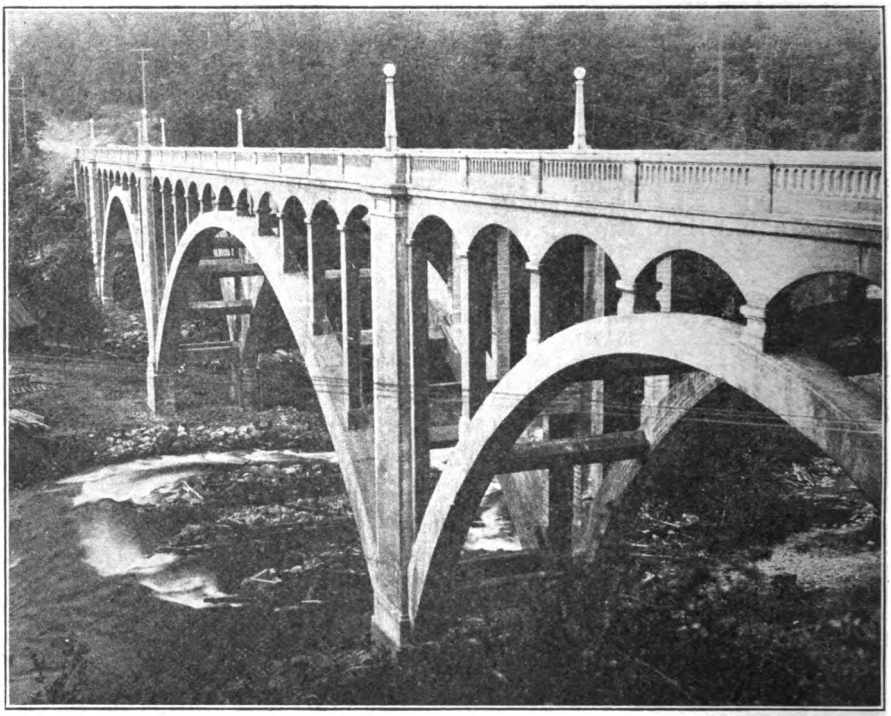

State Highway Bridge over the Sacramento River at Dunsmuir, showing use of California cement and crushed rock in a reinforced concrete structure.

Annual production of cement in California has been as follows:

Year	Barrels	Value	Year	Barrels	Value
1891	5,000	$15,000	1905	1,265,553	$1,791,916
1892	5,000	15,000	1906	1,286,000	1,941,250
1893			1907	1,613,563	2,585,577
1894	8,000	21,600	1908	1,629,615	2,359,692
1895	16,383	32,556	1909	3,779,205	4,969,437
1896	9,500	28,250	1910	5,453,193	7,485,715
1897	18,000	66,000	1911	6,371,369	9,085,625
1898	50,000	150,000	1912	6,198,634	6,074,661
1899	60,000	180,000	1913	6,167,806	7,743,024
1900	52,000	121,000	1914	5,109,218	6,558,148
1901	71,800	159,842	1915	4,918,275	6,044,950
1902	171,000	423,600	1916	5,299,507	6,210,293
1903	640,868	968,727			
1904	969,538	1,539,807	Totals	51,169,027	$66,571,670

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CHROMITE.

Bibliography: State Mineralogist Reports IV, XII, XIII, XIV; Bulletin 38. U. S. G. S., Bull. 430. Min. & Sci. Press, Vol. 114, p. 552.

Chromic iron ore, or chromite, to the amount of 48,943 short tons valued at $717,244, f. o. b. shipping point was mined and shipped in California during the year 1916. This is a thirteen-fold increase in quantity and 19 times the total value for 1915, which showed 3,725 tons worth $38,044. Chromite is widely distributed in this state, the 1916 output coming from 25 counties, the larger amounts being credited to Shasta, Fresno, El Dorado, Tulare, and Siskiyou in the order named.

Economic Conditions.

Chromite is another of California's minerals affected by the economic conditions brought about by the European war. The major portion of our domestic requirements for chrome is for consumption in the steel mills of the east. Formerly, most of that used was imported from Rhodesia and New Caledonia, and they are still the more important sources. The reports of the U. S. Department of Commerce, show the foreign imports of chromic iron for the four years 1913–1916 (inc.) to have been 49,772; 74,686; 76,455; and 114,655 long tons, respectively. Similarly to conditions already discussed under manganese (see *ante*), the increased demand for steel products has also increased the necessity for chromite as a refractory and for the preparation of ferro-chrome. Our own domestic sources are supplying a part of the increased demand, and some tonnage is coming from Canada.

According to Dolbear,[14] "to be readily salable chrome ore should contain at least 40% chromic oxide (Cr_2O_3) and less than 8% silica (SiO_2). Some ore is sold which carries not more than 30% Cr_2O_3; sometimes SiO_2 as high as 10% to 15% is permitted. Ore containing 40% Cr_2O_3 is more satisfactory in fire-brick manufacture that 30% or 50% ore. When other grades are purchased they are sometimes crushed and mixed with higher or lower grades, as may be required, to secure a 40% product."

Occurrence.

Until 1916, when some shipments were made from Oregon and smaller amounts from Maryland, Wyoming and Washington, our only

[14] S. H. Dolbear, Min. & Sci. Press, Apr. 21, 1917, p. 554.

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domestic production of chromite came from California. There are two main belts here yielding this mineral—one, along the Coast Ranges from San Luis Obispo County to the Oregon line, including Klamath Mountains at the north end, and the other in the Sierra Nevada from Tulare County to Plumas County. Chromite occurs as lenses in basic igneous rocks such as peridotite and pyroxenite, and in serpentine which has been derived by alteration of such basic rocks. For the most part, so far as developments have yet shown, the lenses have proven to be small, relatively few of them yielding over 100 tons apiece. A notable exception to this was the deposit on Little Castle Creek near Dunsmuir, from which upwards of 15,000 tons were shipped before it was exhausted. Deposits now being opened up in Del Norte County promise well for a large tonnage, according to recent field observations of a member of the staff of the State Mining Bureau. On the whole, the ore bodies in the northwestern corner of the state appear to average larger in size than the chromite lenses in other parts of California.

Concentration is being considered in several localities to improve the shipping product, and thus utilize some of the disseminated and lower grade ore bodies which have been found.

The major consumption of chromic iron ore is for its use as a refractory lining in smelting furnaces for steel and copper. A smaller portion is used in the preparation of ferro-chrome for chrome-steel alloys. Some of the California product in 1916 was converted into ferro-chrome in the electric furnaces of the Noble Electric Steel Company at Heroult, Cal., and some of it was similarily reduced in electric furnaces at Niagara Falls, N. Y. A small amount of high-grade ore was utilized in preparation of chromates for tanning.

Prices and Production.

During 1916, the prices in California on the basis of 40% chromic oxide ranged from $14–$20 per ton f. o. b., with a premium for higher grades and deductions for lower. The producer's reports to the State Mining Bureau indicate an average of $14.65 per ton received for all grades for the year. In June, 1917, sales were being made at 60¢–65¢ per unit for 40%–45% ore, or $24 per ton for 40%. For the eastern buyer, to these prices must be added $10 per ton freight charges to Chicago, or $14.86 a ton to the eastern seaboard.

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The distribution of the 1916 product, by counties, was as follows:

County	Tons	Value
Alameda	612	$7,344
Amador	300	3,700
Butte	1,451	13,940
Calaveras	1,636	12,570
El Dorado	5,260	72,560
Fresno	9,060	151,824
Lake	871	15,070
Napa	715	11,559
Nevada	981	12,795
Placer	774	11,956
San Luis Obispo	1,855	27,733
Santa Clara	136	2,028
Shasta	12,425	181,225
Siskiyou	2,251	28,731
Sonoma	243	2,478
Tehama	1,896	39,702
Tulare	3,435	42,555
Tuolumne	285	4,556
Del Norte, Glenn, Plumas, Sierra, Stanislaus, Trinity, Yuba*	4,757	74,918
Totals	48,943	$717,244

*Combined to conceal output of a single mine in each.

The annual output of chromite since 1887 has been as follows:

Year	Tons	Value	Year	Tons	Value
1887	3,000	$40,000	1903	150	$2,250
1888	1,500	20,000	1904	123	1,845
1889	2,000	30,000	1905	40	600
1890	3,599	53,985	1906	317	2,859
1891	1,372	20,580	1907	302	6,040
1892	1,500	22,500	1908	350	6,195
1893	3,319	49,785	1909	436	5,309
1894	3,680	39,980	1910	749	9,707
1895	1,740	16,795	1911	935	14,197
1896	786	7,775	1912	1,270	11,260
1897			1913	1,180	12,700
1898			1914	1,517	9,434
1899			1915	3,725	38,044
1900	140	1,400	1916	48,943	717,244
1901	130	1,950			
1902	315	4,725	Totals	83,118	$1,147,259

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GRANITE.

Bibliography: State Mineralogist Reports X, XII, XIII, XIV; Bulletin 38.

In the reports for several years previous to the present one, granite was treated in a subdivision under "Stone Industry" or under "Miscellaneous Stone." We have here rearranged the subjects, somewhat, and now give granite a separate heading, as had previously been done with marble and sandstone. Crushed rock and paving blocks derived from granite quarries are continued under the heading of "Miscellaneous Stone."

The output of granite, particularly for building and ornamental purposes shows a falling off the past two years, from earlier annual amounts. In 1915, this was due mainly to a strike of the granite cutters which covered practically all of the last half of the year. That granite is not used more is probably due to its greater cost as compared to concrete and ornamental brick and tile for building. In 1916, the San Francisco City Hall and the Sub-Treasury Building having been completed, the only other large public buildings under construction utilizing granite were two on the campus of the University of California in Berkeley.

California building granites, particularly the varieties from Raymond, Madera County, and Rocklin, Placer County, are unexcelled by any similar stone found elsewhere. In so far as it has been possible to do so, granite production has been segregated in the following table into the various uses to which the product was put. It will be noted, however, that a portion of the output has been entered under the heading "Unclassified". This is necessary because of the fact that some of the producers have no way of telling to what specific use their stone was put after they had quarried and sold the same.

The distribution of the 1916 product, by counties, was as follows:

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Granite Production, by Counties, for 1916.

County	Building stone		Monumental		Curbing		Unclassified		Total value
	Cubic feet	Value	Cubic feet	Value	Linear feet	Value	Cubic feet	Value	
Fresno			11,000	$25,000					$25,000
Madera	104,507	$162,183	21,672	8,934			2,686	$1,074	172,191
Napa							[1]119,500	5,500	5,500
Nevada			100	100					100
Placer	16,043	12,123	16,101	19,758	59,122	$45,840	4,278	3,210	80,931
Riverside			1,400	1,260			7,260	3,630	4,890
San Bernardino							[2]7,500	2,500	2,500
Humboldt, Plumas, San Diego, Santa Barbara, Siskiyou, Sonoma, Tehama, Tulare*	48,500	13,900	14,651	29,308	2,354	7,250	[3]2,245,744	193,769	244,227
Totals	169,050	$188,206	64,924	$84,360	61,476	$53,090	2,386,968	$209,683	$535,339

[1]Tuff; in part, rough ashlar for walls.
[2]Includes a stone used as a cement kiln liner.
[3]Includes basalt.
*Combined to conceal output of a single operator.

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The value of granite produced, annually since 1887, has been as follows:

Year	Value	Year	Value
1887	$150,000	1903	$678,670
1888	57,000	1904	467,472
1889	1,329,018	1905	353,837
1890	1,200,000	1906	344,083
1891	1,300,000	1907	373,376
1892	1,000,000	1908	512,923
1893	531,322	1909	376,834
1894	228,816	1910	417,898
1895	224,329	1911	355,742
1896	201,004	1912	362,975
1897	188,024	1913	981,277
1898	147,732	1914	628,786
1899	141,070	1915	227,928
1900	295,772	1916	535,339
1901	519,285		
1902	255,239	Total	$14,385,751

LIME.

Bibliography: Bulletin 38.

Lime to the amount of 493,635 barrels, valued at $390,475, was produced from eight counties during 1916, as compared with 356,534 barrels, valued at $286,304, in 1915. This figure includes only such lime as is used in building operations. That utilized in sugar making, for smelter flux, and as a fertilizer are classified under "Industrial Materials". That consumed in cement manufacture is included in the value of cement.

Distribution, by counties, is shown in the following table:

County	Barrels	Value
San Bernardino	151,670	$54,317
Santa Cruz	176,263	225,485
Amador, El Dorado, Kern, Shasta, Siskiyou, Tuolumne*	165,702	110,673
Totals	493,635	$390,475

*Combined to conceal output of a single plant in each.
For table of production by years, see under "industrial" limestone.

MAGNESITE.

Bibliography: State Mineralogist Reports XII, XIII, XIV; Bulletin 38. U. S. G. S. Bulletins 355, 540. Min. & Sci. Press, Vol. 114, p. 237.

Magnesite has for a number of years been known to exist in many localities in California. In quality it is very high grade, many deposits yielding material carrying above 95% magnesium carbonate. The

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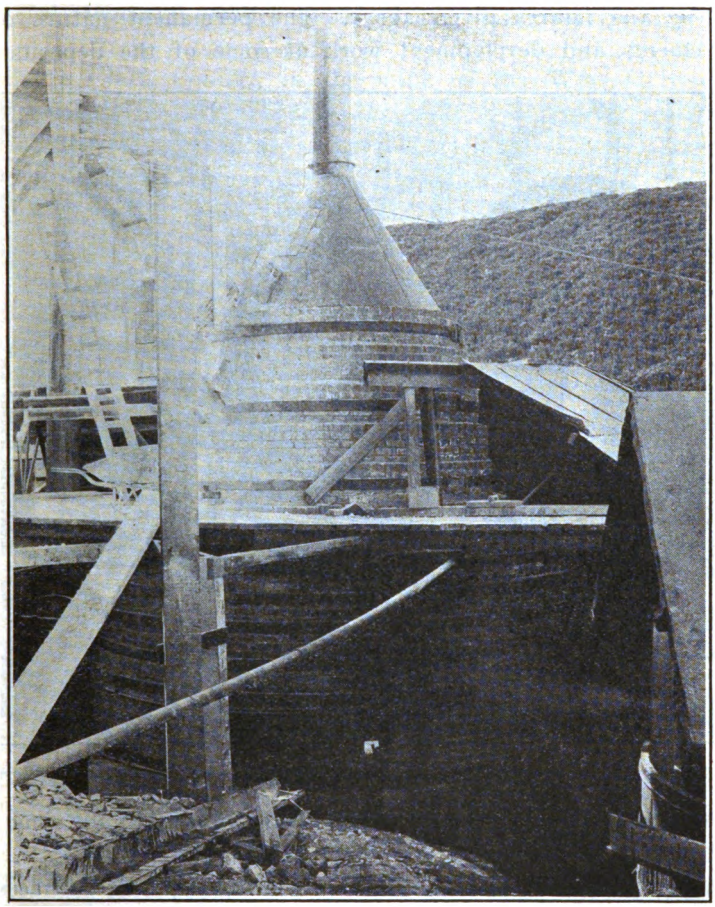
deposits are mostly in the metamorphic rocks of the Coast Range and Sierra Nevada Mountains, and are scattered over an area nearly four hundred miles long. One deposit of sedimentary origin is situated in the Mojave Desert region, in Kern County. Up to the end of 1916, California was the only state, of record, in the United States, producing magnesite in commercial quantities (or in fact, on the North American



Shaft furnace of Western Magnesite Development Co., at Red Mountain, Santa Clara County, California.

Continent). For the current year, 1917, Washington has joined us. In 1916, a small tonnage of magnesite was shipped from Atlin, British Columbia, to England.

During the year 1916, the activity begun in 1915 not only continued but was increased several-fold, so that California's output was raised from the 30,721 tons worth $283,461 in 1915 to 154,052 tons worth

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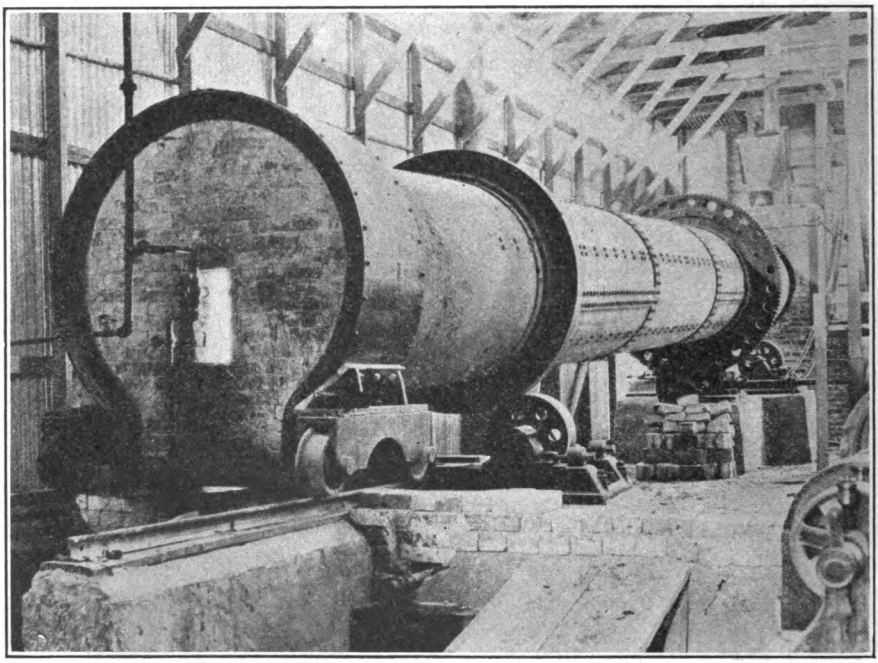
$1,311,893 in 1916. This exceeds both in tonnage and value the previous total output of the state to the end of 1915. The great activity in the steel industry has called for a much larger tonnage of refractories, such as magnesite and chrome, for furnace linings. The complete shutting off of the Austrian supplies, and transportation difficulties interfering with importations from Greece, has caused the eastern steel operators to look to California for magnesite. How well we have responded is shown by the figures given above. The permanent nature of the improvements and development work at some of the deposits gives



Rotary kiln of Sonoma Magnesite Co., at Magnesite, Sonoma County, California.

promise that future production will continue important for some years yet, at least.

The photographs, herewith, illustrate the two types of furnaces used in calcining magnesite in California.

Producing Districts.

The Porterville district in Tulare County continues to be the most important in the state. The Tulare Mining Company, for some years past the largest single producer, was closely pressed in 1916 by two others. The magnesite is stoped in underground workings, and calcined in two vertical shaft kilns. A railroad spur runs direct to the furnaces. The Porterville Magnesite Company both stopes and quarries

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its ore, and for the greater part of 1916 shipped the product crude, later putting a rotary kiln into service. A second rotary has since been installed. The Lindsay Mining Company built a railroad spur to its loading chutes, and for a time shipped the crude ore direct east. Now they ship to the calcining plant of the American Magnesite Company at Porterville, where two rotary kilns are in operation. There are several other and smaller operators in Tulare County, all shipping crude.

In Santa Clara County, in the mine of the Western Magnesite Development Co. at Red Mountain, the material is stoped underground, calcined in two vertical kilns, and transported 33 miles by auto trucks to the railroad at Livermore. The adjoining property of the Pacific Magnesite Company also made shipments. The Sherlock mine near Madrone was idle in 1916, but has since resumed work.

The Sonoma Magnesite Company near Cazadero, Sonoma County, extracted its ore both by stope and quarry, and had a rotary kiln in operation. Shipments of both raw and calcined ore were made, the former to steel mills and the latter to the plastic trade. The Refractory Magnesite Company at Preston has an ore which is an isomorphous mixture of magnesite and siderite (ferrous carbonate), and burns brown, carrying up to 6% Fe_2O_3. When calcined it resembles the Austrian "spaeder," particularly desired by the steel men. A vertical kiln is in operation, and the product is hauled two miles down a rather steep road to the railroad. Shipments of crude ore were made from several smaller properties in Sonoma County during the year.

A considerable tonnage was shipped from the sedimentary deposit at Bissell, in Kern County, and calcined in two rotary kilns at Los Angeles before shipment east. Production, also, was resumed at Winchester in Riverside County.

In Napa County a considerable tonnage was shipped, crude, from the White Rock mine in Pope Valley, also from the property of the Tulare Mining Company and one or two others near Rutherford. For the current year, 1917, the White Rock has 5 vertical kilns of 10 tons capacity, crude ore each, per day in operation, and they are contemplating an increase; and there is a customs plant with two vertical kilns in operation at Rutherford.

The John D. Hoff Asbestos Company in Oakland had two vertical kilns in operation on purchased ore for plastic work, and are building a second plant with two kilns at Bay Point, Contra Costa County. A calcining plant utilizing the derived carbonic acid gas is in operation in Berkeley on custom ore; and there is a plant at San Diego burning magnesite from Lower California, Mexico. To date, this last-mentioned has not treated any California magnesite.

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In addition to the above-mentioned, some production was made in 1916, in Alameda County at Cedar Mountain, in Fresno at Piedra, and in Mendocino County.

Uses.

The principal uses at the present time include: refractory linings for basic open-hearth steel furnaces, copper reverberatories and converters, bullion and other metallurgical furnaces; in the manufacture of paper from wood pulp; and in structural work, for flooring, wainscoting, tiling, sanitary kitchen and hospital finishing, etc. In connection with building work it has proven particularly efficient as a flooring for steel railroad coaches, on account of having greater elasticity and resilience than "Portland" cement. For refractory purposes, the magnesite is "dead-burned"—*i. e.*, all or practically all of the CO_2 is expelled from it. For cement purposes, it is left "caustic"—*i. e.*, from 5% to 10% of CO_2 is retained. When dry caustic magnesite is mixed with a solution of magnesium chloride ($MgCl_2$) in proper proportions, a very strong cement is produced, known as oxychloride or Sorel cement.[15] "It is applied in a plastic form, * * * which sets in a few hours as a tough, seamless surface. It has also a very strong bonding power, and will hold firmly to wood, metal, or concrete as a base. It may be finished with a very smooth, even surface, which will take a good wax or oil polish. As ordinarily mixed there is added a certain proportion of wood flour, cork, asbestos, or other filler, thereby adding to the elastic properties of the finished product." Its surface is described as "warm" and "quiet" as a result of the elastic and nonconducting character of the composite material. The cement is usually colored by the addition of some mineral pigment to the materials before mixing as cement.

The desirable qualities of any flooring material (cost not considered) are listed for purposes of analysis or comparison under eighteen heads, as follows: Cleanliness (sanitary qualities), quietness, immunity from abrasion (surface wear), resilience, immunity from slipperiness, appearance, waterproof character, plasticity, warmth (thermal insulation), life (immunity from deterioration with age), acid-proof character, alkali-proof character, fire resistance, elasticity, crushing strength, structural strength (rupture), immunity from expansion and contraction, and lightness. The importance of these several qualities varies with the varying requirements to be met: for instance, in some places, as in hospitals, cleanliness is one of the prime considerations; in other places immunity

[15] In this summary of the uses and properties of magnesia cement we have drawn freely from the following references:
Eng. Soc. Western Pennsylvania Proc., 1913, vol. 29, pp. 305–338, 418–444;
U. S. G. S., Mineral Resources, 1913, Part II, pp. 450–453.

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from abrasion might be one of the principal requisites. As to most of these qualities the conclusion is reached that the magnesia cement affords one of the most satisfactory flooring materials for many purposes such as in kitchen, laundry, toilet, and bathrooms, corridors, large rooms or halls in public or other buildings, including hospitals, factories, shops and restaurants.

There is no doubt that the material is steadily coming into more general recognition and favor for these uses. For a few special uses it is more or less disqualified; as an instance, it is not suited for construction of swimming tanks or for conditions of permanent wetness, since under constant immersion it gradually softens, although it is said to withstand intermittent wetting and drying and is recommended for shower baths. Naturally it is not acid-proof and not wholly alkali-proof, which might be a disadvantage in use for laboratory floors and tables; but these are rather special requirements. Its cost per square foot is given as 25 to 33 cents, depending on area, which is estimated to be lower than marble, cork, rubber, clay or mosaic tile, slate, or terrazzo, although more expensive than wood, asphalt, linoleum, or Portland cement.

In the discussion of the subject the causes of failure are ascribed to uncertain climatic changes, lack of uniformity in the mixtures used, lack of care on the part of those handling the materials, possible deterioration of materials used through exposure (either before or after mixing), lack of proper preparation of foundations on which the material is to be laid, and, as a very important factor, experience or nonexperience in the manipulation or actual laying and troweling of the material. Data concerning the percentages of magnesium chloride and of ground calcined magnesia and data concerning the character and quantity of filler and color added to the commercial preparations are naturally guarded as trade secrets by the firms already in the business. The examination and standardization of the raw materials used, and of acceptable filler materials, and the establishment of standard proportions for the mixtures would seem to be about the only satisfactory way of attacking the problem.

The condition of the calcination of magnesite for cement uses is important, as the same material may undoubtedly be very greatly varied in its reacting properties by differing treatment in the kiln. It is generally agreed that the magnesite for cement use must be comparatively free from lime, as lime has a greater tendency to reabsorb water and carbon dioxide than the magnesia, thereby causing swelling, and is therefore not so permanent in the completed cement as a pure magnesia material. The fillers used may constitute 10% to 40%

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of the whole cement, and commonly consist of ground marble, sand, sawdust, cork, asbestos, or other materials. As an example of the formulas used in mixing such cements the following are quoted:[16]

Mixtures for the underlying or coarser layer.

[Parts by weight.]

1. 15 parts magnesia.
   10 parts magnesium chloride solution, 20° Baumé.
   10 parts moist sawdust.
   (Sets in 36 hours.)
2. 10 parts magnesia.
   10 parts magnesium chloride solution, 28° Baumé.
   5 parts sawdust.
   (Sets in 16 hours.)
3. 20 parts magnesia.
   15 parts magnesium chloride solution, 20° Baumé.
   4 parts ground cork.
   (Sets in 24 hours.)
4. 5 parts magnesia.
   3 parts magnesium chloride solution, 20° Baumé.
   5 parts ashes.
   (Sets in 24 hours.)

Mixtures for overlying or surface layers.

[Parts by weight.]

1. 40 parts magnesia.
   33 parts magnesium chloride solution, 19° Baumé.
   10 parts asbestos powder.
   5 parts wood flour.
   1 part red ocher.
   (Sets in 24 hours.)
2. 25 parts magnesia.
   25 parts magnesium chloride, 21° Baumé.
   4½ parts wood flour, impregnated with 4½ parts Terpentinharzlösung.
   15 parts yellow ocher.
   (Sets in 30 hours.)

The magnesite used is, as explained, the fine ground calcined (not dead-burned) of certain specified kinds or place of derivation regularly sold for the plastic purposes. This material commonly comes in paper-lined casks, barrels, or boxes, in which form it is fairly permanent, but it deteriorates by exposure, absorbing carbonic acid and moisture from the air. If carefully handled it can probably be kept unopened a year or more, but it should be used within a few weeks after being opened, even under most favorable conditions.

[16] Scherer, Robert—Der Magnesit, sein Vorkommen, seine Gewinnung und technische Verwertung, pp. 216–217, A. Hartleben's Bibliothek, Wien und Leipzig, 1908.

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It is stated that some metallic magnesium is at present being prepared electrolytically at Niagara Falls, from magnesite (see also Magnesium Chloride, under Salines-*post*).

Output and Value.

In considering mineral production the value of the crude material is used as far as practicable. Magnesite presents a peculiar example of a material which previous to the present activity was seldom handled on the market in the crude state. It is ordinarily calcined and ground before being considered marketable. The value of the calcined magnesite varies, the San Francisco price for 1916 ranging from $25 to $45 per ton, which figure includes about $4 per ton freight. From 2 to 2½ tons of the crude material are mined to make one ton of the calcined. In previous reports the foregoing circumstances were used in calculating an arbitrary value for the crude material at the mine, there having been very little product shipped crude. On a similar basis, the value of the 1916 crude would have been approximately $16 per ton. On the contrary, however, considerable tonnages were in 1916 shipped in the crude state, contracted for at prices ranging from $6 to $10 per ton, f. o. b. rail points, or an average of about $8 per ton. Prices for 1917, are so far, higher, some sales having been made in June at $12.50 f. o. b. for crude.

Magnesite products have been found to be highly satisfactory and are growing in popularity, and the future for this industry appears to be bright. A large supply is already known to exist in California, and only a sufficient demand and cheaper transportation are lacking to make this an item of greater consequence in the mineral total of the state.

Production of crude magnesite for 1916, by county, is given in the following table, with total crude value:

County	Tons	Value
Fresno	5,829	$49,082
Mendocino	300	2,400
Merced	90	720
Napa	13,960	108,556
Santa Clara	23,207	232,156
Sonoma	11,653	98,280
Tulare	87,606	737,130
Alameda, Kern, Placer, Riverside, Tuolumne*	11,407	83,569
Totals	154,052	$1,311,893

*Combined to conceal output of a single producer in each.

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Annual production for California, amount and value, since 1887, is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1887	600	$9,000	1903	1,361	$20,515
1888	600	9,000	1904	2,850	9,298
1889	600	9,000	1905	3,933	16,221
1890	600	9,000	1906	4,032	40,320
1891	1,500	15,000	1907	6,405	57,720
1892	1,500	15,000	1908	10,582	80,822
1893	1,093	10,930	1909	7,942	62,588
1894	1,440	10,240	1910	16,570	113,887
1895	2,200	17,000	1911	8,858	67,430
1896	1,500	11,000	1912	10,512	105,120
1897	1,143	13,671	1913	9,632	77,056
1898	1,263	19,075	1914	11,438	114,380
1899	1,280	18,480	1915	30,721	283,461
1900	2,252	19,333	1916	154,052	1,311,893
1901	4,726	43,057			
1902	2,830	20,655	Totals	304,015	$2,610,152

MARBLE.

Bibliography: State Mineralogist Reports XII, XIII, XIV; Bulletin 38. U. S. Bur. of M., Bull. 106.

Marble is widely distributed in California; and in a considerable variety of colors and grain. During 1916, the production amounted to 25,954 cubic feet, valued at $50,280, from Inyo, Santa Cruz, Tulare and Tuolumne counties. This shows a slight increase over the previous year, though still below what might be considered the normal output of former years, and certainly far below our possibilities.

The decrease in output of marble in recent years is probably due in part to the fact that foreign, eastern and Alaskan marbles are landed here by water cheaper than much of our local stone can be put on the market, on account of our higher labor costs and transportation difficulties, though California has many beautiful and serviceable varieties.

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Data on annual production since 1887, as compiled by the State Mining Bureau, follows. Previous to 1894 no records of amount were preserved:

Year	Cubic feet	Value	Year	Cubic feet	Value
1887		$5,000	1903	84,624	$97,354
1888		5,000	1904	55,401	94,208
1889		87,030	1905	73,303	129,450
1890		80.000	1906	31,400	75,800
1891		100,000	1907	37,512	118,066
1892		115,000	1908	18,653	47,665
1893		40.000	1909	79,600	238,400
1894	38,441	98,326	1910	18,960	50,200
1895	14,864	56,566	1911	20,201	54,103
1896	7,889	32,415	1912	27,820	74,120
1897	4,102	7,280	1913	41,654	113,282
1898	8,050	23,594	1914	25,436	48,832
1899	9,682	10.550	1915	22,186	41,518
1900	4,103	5,891	1916	25,954	50,280
1901	2,945	4,630			
1902	19,305	37,616	Total value		$1,942,176

ONYX AND TRAVERTINE.

Bibliography: State Mineralogist Reports XII, XIII, XIV; Bulletin 38.

Onyx and travertine are known to exist in a number of places in California, but there has been no production reported since the year 1896.

Production by years is as follows:

Year	Value	Year	Value
1887	$900	1893	$27.000
1888	900	1894	20,000
1889	900	1895	12,000
1890	1,500	1896	24,000
1891	2,400		
1892	1,800	Total	$91,400

SANDSTONE.

Bibliogrophy: State Mineralogist Reports XII, XIII, XIV; Bulletin 38. U. S. Bur. of M., Bull. 124.

An unlimited amount of high-grade sandstone is available in California, but the wide use of concrete in buildings of every character, as well as the popularity of a lighter colored building stone, has retarded this branch of the mineral industry very seriously during recent years. In 1916 six counties—Amador, Colusa, San Luis Obispo,

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Santa Barbara, Siskiyou, and Ventura—turned out 17,270 cubic feet, valued at $10,271, which is a considerable drop from former years. The main feature of the loss the past two years is the closing of the well-known Colusa quarries, on account of the competition of lighter colored materials.

Amount and value, as far as contained in the records of this Bureau, are presented herewith, with total value from 1887 to date:

Year	Cubic feet	Value	Year	Cubic feet	Value
1887		$175,000	1903	353,002	$585,309
1888		150,000	1904	363,487	567,181
1889		175,598	1905	302,813	483,268
1890		100,000	1906	182,076	164,068
1891		100,000	1907	159,573	148,148
1892		50,000	1908	93,301	55,151
1893		26,314	1909	79,240	37,032
1894		113,592	1910	165,971	80,443
1895		35,373	1911	255,313	127,314
1896		28,379	1912	66,487	22,574
1897		24,086	1913	62,227	27,870
1898		46,384	1914	111,691	45,322
1899	56,264	103,384	1915	63,350	8,438
1900	378,468	254,140	1916	17,270	10,271
1901	266,741	192,132			
1902	212,123	142,506	Total value		$4,079,277

SERPENTINE.

Bibliography: Bulletin 38.

Serpentine has not been produced in California at any time, to a very large extent, owing to defects in the stone, most of which is not of good texture.

The following table shows the amount and value of serpentine since 1895 as recorded by this Bureau:

Year	Cubic feet	Value	Year	Cubic feet	Value
1895	4,000	$4,000	1903	99	$800
1896	1,500	6,000	1904	200	2,310
1897	2,500	2,500	1905		
1898	750	3,000	1906	847	1,694
1899	500	2,000	1907	1,000	3,000
1900	350	2,000			
1901	89	890			
1902	512	5,065	Totals	12,347	$33,259

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SLATE.

Bibliography: Bulletin 38.

Slate was first produced in California in 1889. Up to and including 1910 such production was continuous, there being none between that year and 1915, when there was an output of 1,000 squares reported, valued at $5,000. Many large deposits are known in the state, especially in El Dorado, Calaveras and Mariposa counties, but the demand has been light owing principally to competition of cheaper roofing materials.

The property of the Eureka Slate Company in El Dorado was in 1916 taken over by the Sierra Slate Corporation of New York, and, it is stated, will be operated on a large scale. This will be the only quarry producing roofing slate, commercially, west of Pennsylvania. This Eureka roofing slate has been passed upon as one of three brands acceptable on Federal work, the other two being from Maine and Pennsylvania, respectively.

The new company expects to prepare for market from 1,000 to 3,000 squares per month. A "square" of roofing slate is a sufficient number of pieces of any size to cover 100 square feet of roof, with allowance generally for a three-inch lap. The size of the pieces of slate making up a square ranges from 7 x 9 inches to 16 x 24 inches, and the number of pieces in a "square" ranges from 85 to 686; and it is worth $3.50 to $10 per square, f. o. b. quarry, depending on quality. The Ferry Building, San Francisco, is roofed with Eureka slate.

A complete record of amount and value of slate produced in California follows:

Year	Squares	Value	Year	Squares	Value
1889	4,500	$18,089	1904	6,000	$50,000
1890	4,000	24,000	1905	4,000	40,000
1891	4,000	24,000	1906	10,000	100,000
1892	3,500	21,000	1907	7,000	60,000
1893	3,000	21,000	1908	6,000	60,000
1894	1,800	11,700	1909	6,961	45,660
1895	1,350	9,450	1910	1,000	8,000
1896	500	2,500	1911	----------	----------
1897	400	2,800	1912	----------	----------
1898	400	2,800	1913	----------	----------
1899	810	5,900	1914	----------	----------
1900	3,500	26,250	1915	1,000	5,000
1901	5,100	38,250	1916	----------	----------
1902	4,000	30,000			
1903	10,000	70,000	Totals	88,821	$676,399

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MISCELLANEOUS STONE.

Bibliography: State Mineralogist Reports XII, XIII, XIV. Bulletin 38.

Miscellaneous stone is the name used throughout this report as the title for that branch of the mineral industry covering crushed rock of all kinds, paving blocks, sand and gravel, and pebbles for grinding mills. The foregoing are very closely related from the standpoint of the producer. Thus it has been found to be most satisfactory to group these items as has been done in recent reports of this Bureau. In so far as it has been possible to do so, crushed rock production has been subdivided into the various uses to which the product was put. It will be noted, however, a very large percentage of the output has been tabulated under the heading "Unclassified." This is necessary because of the fact that many of the producers have no way of telling to what specific use their rock was put after they have quarried and sold the same.

In addition to amounts produced by commercial firms, both corporations and individuals, there is hardly a county in the state but uses more or less gravel and broken rock on its roads. Of much of this, particularly in the country districts, there is no definite record kept. Estimates have been made for some of this output, based on the mileage of roads repaired.

For the year 1916, miscellaneous stone shows a decrease from the preceding year of $611,661 in value. Apparently construction work has not entirely recovered from the slump in 1914. The total value for 1916 was $4,171,519 as compared with $4,783,180 for 1915, with $4,231,571 for 1914, and $5,186,743 for 1913.

As has been the case for several years past, Los Angeles County led all others by a wide margin, with an output valued at $971,153; followed by Alameda, second, with $403,587; Contra Costa, third, $363,753; and Sonoma, fourth, $254,966.

In California, the general construction situation in 1916 appeared about normal so far as small jobs were concerned; but there were few large pieces of work done except highway contracts.

Paving Blocks.

The paving block industry has decreased materially of recent years, because of the increased construction of smoother pavements demanded by motor vehicle traffic. The blocks made in Solano County were of basalt; those from Sonoma are of basalt, andesite and some trachyte; while those from all the other counties shown in the tabulation, are of granite.

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Paving Block Production, by Counties, for 1916.

County	Amount M.	Value
Placer	367	$12,010
Riverside	172	6,743
Sonoma	693	31,509
Sacramento, San Bernardino, San Diego*	90	4,100
Totals	1,322	$54,362

*Combined to conceal output of single operator in each.

The amount and value of paving block production annually since 1887 has been as follows:

Year	Amount M.	Value	Year	Amount M.	Value
1887	*10,000	$350,000	1903	4,854	$134,642
1888	10,500	367,500	1904	3,977	161,752
1889	7,303	297,236	1905	3,408	134,347
1890	7,000	245,000	1906	4,203	173,432
1891	5,000	150,000	1907	4,604	199,347
1892	*3,000	96,000	1908	7,660	334,780
1893	2,770	96,950	1909	4,503	199,803
1894	2,517	66,981	1910	4,434	198,916
1895	2,332	73,338	1911	4,141	210,819
1896	4,161	77,584	1912	11,018	578,355
1897	1,711	35,235	1913	6,364	363,505
1898	1,144	21,725	1914	6,053	270,598
1899	305	7,861	1915	3,285	171,092
1900	1,192	23,775	1916	1,322	54,362
1901	1,920	41,075			
1902	3,502	112,437	Totals	134,183	$5,248,447

*Figures for 1887–1892 (inc.) are for Sonoma County only, as none are available for other counties during that period; though Solano County quarries were then also quite active.

Grinding Mill Pebbles.

In 1915, for the first time we were able to record a production of pebbles for tube and other grinding mills. Owing to the decreased imports and higher prices of Belgium and other European flint pebbles, there has been a serious inquiry for domestic sources of supply.

One of the shipments made in that year was of pebbles selected from gold dredger tailings in Sacramento County, for use in a gold mill in Amador County employing Hardinge mills. It is stated that the consumption was about 3 to 1 as compared to Danish pebbles; and that the long wagon haul, coupled with the heavy consumption, made the cost not economic. Had the pebbles been selected by men with some knowledge of rocks instead of by inexperienced laborers as in this case, a better grade would have been obtained, which no doubt would have proven of better service.

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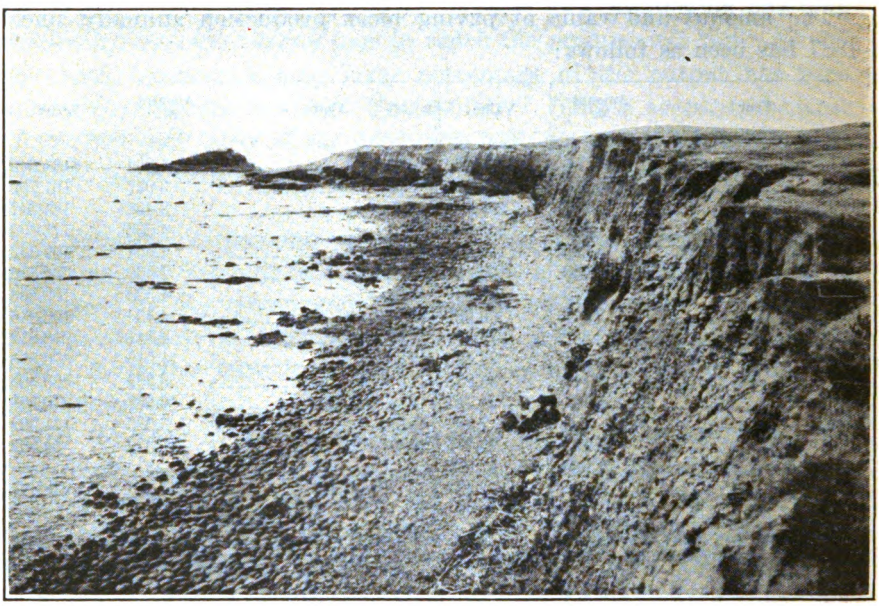
The important development in this item, however, has been in San Diego County. At several points along the ocean shore from Encinitas south to near San Diego, there are beaches of washed pebbles varying from 1 inch to 6 inches in diameter. At one of these localities visited by the writer in May, 1916, there is a conglomerate stratum forming a part of the sea-cliff. This conglomerate is made up of well-rounded water-worn pebbles of various granitic and porphyritic rocks with some felsite and flint. The wave action has broken down portions of the cliffs for considerable distances and formed beaches of the pebbles



Grinding mill pebbles, on beach at Bird Rock, near San Diego, California.

which are well washed and cleaned of the softer materials. The rocks sorted out for shipment are mainly basalt and diabase, with an occasional felsite and flint pebble. There is a tough, black basalt which is stated to be giving satisfactory results. The Fresno County pebbles are selected from the gravel beds near Friant. Shipments are being made to metallurgical plants in California, Nevada, Montana and Utah.

Grinding Mill Pebbles Production, for 1916.

County	Tons	Value
Fresno and San Diego*	20,232	$107,567

*Combined to conceal output of a single producer in Fresno County.

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The amount and value of grinding mill pebbles, annually, follows:

Year	Tons	Value
1915	340	$2,810
1916	20,232	107,567
Totals	20,572	$110,377

Sand and Gravel Production, by Counties, for 1916.

County	Tons	Value	County	Tons	Value
Alameda	[1]645,979	$176,739	Sacramento	138,108	$36,404
Amador	1,000	300	San Benito	3,660	1,250
Calaveras	7,690	1,922	San Bernardino	30,049	7,059
Colusa	2,200	550	San Diego	[2]58,183	33,008
Contra Costa	114,223	41,810	San Joaquin	88,247	37,300
Del Norte	2,200	800	San Luis Obispo	23,192	9,318
El Dorado	16,000	5,500	Santa Barbara	15,467	6,300
Fresno	165,118	63,023	Santa Clara	179,582	58,896
Glenn	540,329	41,180	Siskiyou	7,484	2,207
Humboldt	31,802	30,891	Solano	500	200
Inyo	4,290	4,290	Sonoma	154,156	25,962
Lake	10,000	4,000	Stanislaus	32,505	9,937
Lassen	3,335	1,350	Tulare	51,147	10,288
Los Angeles	1,405,800	322,919	Tuolumne	2,000	500
Madera	13,333	6,250	Yuba	237,072	42,685
Marin	1,000	250	Butte, Kern, San Francisco, San Mateo, Tehama, Trinity, Ventura*	290,163	42,764
Mendocino	1,100	275			
Monterey	113,645	46,873			
Napa	113,501	60,275			
Nevada	2,100	525			
Orange	21,516	3,773	Totals	4,566,476	$1,156,773
Riverside	38,800	19,200			

*Combined to conceal output of a single operator in each.
[1]Includes moulding sand.
[2]Includes sand for asphalt finishing; also moulding sand.

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Crushed Rock Production, by Counties, for 1916.

County	Macadam and ballast		Rubble and riprap		Concrete		Unclassified		Totals	
	Tons	Value	Tons	Value	Tons	Value	Tons	Value	Tons	Value
Alameda	60,823	$26,506	----------	----------	124,979	$79,674	191,336	$120,668	377,138	$226,848
Amador	2,500	1,000	----------	----------	----------	----------	----------	----------	2,500	1,000
Calaveras	2,325	581	----------	----------	----------	----------	----------	----------	2,325	581
Contra Costa	267,441	179,577	11,880	$3,564	226,572	138,732	934	70	506,827	321,943
Del Norte	1,850	775	----------	----------	50	75	25	35	1,925	885
El Dorado	16,500	6,500	----------	----------	----------	----------	----------	----------	16,500	6,500
Humboldt	18,134	24,468	1,008	618	2,272	2,423	4,000	1,860	25,414	29,369
Kern	----------	----------	----------	----------	112,600	56,300	----------	----------	112,600	56,300
Lake	2,000	500	----------	----------	----------	----------	----------	----------	2,000	500
Lassen	8,935	8,375	----------	----------	----------	----------	----------	----------	8,935	8,375
Los Angeles	189,770	146,250	114,834	90,504	54,463	23,276	894,131	388,204	1,253,198	648,234
Madera	----------	----------	6,061	1,665	----------	----------	----------	----------	6,061	1,665
Marin	5,000	2,000	40,697	24,661	117,189	77,395	----------	----------	162,886	104,056
Mariposa	----------	----------	----------	----------	----------	----------	79,272	39,372	79,272	39,372
Mendocino	20,000	8,000	----------	----------	----------	----------	----------	----------	20,000	8,000
Modoc	500	200	----------	----------	----------	----------	----------	----------	500	200
Monterey	11,000	7,100	400	400	1,100	650	6,000	3,600	18,500	11,750
Napa	39,040	26,780	----------	----------	2,215	1,386	----------	----------	41,255	28,166
Nevada	2,000	700	----------	----------	----------	----------	----------	----------	2,000	700
Placer	----------	----------	9,785	3,016	2,667	2,000	----------	----------	12,452	5,016
Plumas	8,555	1,988	----------	----------	----------	----------	----------	----------	8,555	1,988
Riverside	[1]224,877	105,694	20,873	9,393	45,000	18,000	150	525	290,900	133,612
San Bernardino	----------	----------	361,000	102,675	200	220	120,000	60,000	481,200	162,895
San Francisco	63,921	43,816	----------	----------	49,806	29,067	6,139	2,854	119,866	75,737
San Mateo	15,012	11,950	2,562	2,563	12,500	9,900	----------	----------	30,074	24,413
Santa Clara	49,833	30,177	----------	----------	59,090	22,181	800	720	109,723	53,078
Santa Cruz	2,512	2,815	----------	----------	----------	----------	----------	----------	2,512	2,815
Shasta	2,500	800	----------	----------	----------	----------	----------	----------	2,500	800
Solano	17,500	12,600	----------	----------	----------	----------	59,641	36,911	77,141	49,511
Sonoma	19,699	11,980	229,986	129,379	1,020	871	63,728	32,412	314,433	174,642
Sutter	----------	----------	----------	----------	----------	----------	5,733	6,450	5,733	6,450

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Tehama	3,451	2,588							3,451	2,588
Trinity	1,000	500							1,000	500
Tulare	10,000	4,704					144,688	67,263	154,688	71,967
Tuolumne	3,000	1,000							3,000	1,000
Ventura			300	200	10,000	5,000			10,300	5,200
Yolo	1,000	300							1,000	300
Butte, Fresno, Imperial, Inyo, Sacramento, San Benito, San Diego, San Joaquin, San Luis Obispo, Santa Barbara, Siskiyou, Stanislaus*	510,573	219,247	56,117	14,702	462,578	288,468	86,981	63,444	1,116,249	585,861
Totals	1,581,251	$889,471	855,503	$383,340	1,284,301	$755,618	1,663,558	$824,388	5,384,613	$2,852,817

*Combined to conceal output of a single operator in each.
[1]Includes limestone used as an asphalt filler.

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A comparison of the table of annual productions of these materials with the similar table for cement (see *ante*), reveals the fact that the important growth of the crushed rock and gravel business was coincident with the rapid development of the cement industry from the year 1902.

The amount and value, annually, of crushed rock (including macadam, ballast, rubble, rip-rap, and that for concrete), and sand and gravel, since 1893, follow:

Crushed Rock, Sand and Gravel, by Years.

Year	Tons	Value	Year	Tons	Value
1893	371,100	$456,075	1906	1,555,372	$1,418,406
1894	661,900	664,838	1907	2,288,888	1,915,015
1895	1,254,688	1,095,939	1908	3,998,945	3,241,774
1896	960,619	839,884	1909	5,531,561	2,708,326
1897	821,123	600,112	1910	5,827,828	2,777,690
1898	1,177,365	814,477	1911	6,487,223	3,610,357
1899	964,898	786,892	1912	8,044,937	4,532,598
1900	789,287	561,642	1913	9,817,616	4,823,056
1901	530,396	641,037	1914	9,288,397	3,960,973
1902	2,056,015	1,249,529	1915	10,879,497	4,609,278
1903	2,215,625	1,673,591	1916	9,951,089	4,009,590
1904	2,296,898	1,641,877			
1905	2,624,257	1,716,770	Totals	90,395,524	$50,349,726

Total Value of Production of "Miscellaneous Stone" (Crushed Rock, Sand, Gravel, Paving Blocks and Grinding Mill Pebbles), by Counties, for 1916.

County	Value	County	Value
Alameda	$403,587	Riverside	$159,555
Amador	1,300	Sacramento	194,718
Butte	67,892	San Benito	155,250
Calaveras	2,503	San Bernardino	172,454
Colusa	550	San Diego	163,925
Contra Costa	363,753	San Francisco	76,437
Del Norte	1,685	San Joaquin	53,075
El Dorado	12,000	San Luis Obispo	49,318
Fresno	95,830	San Mateo	25,663
Glenn	41,180	Santa Barbara	12,395
Humboldt	60,260	Santa Clara	111,974
Imperial	34,834	Santa Cruz	2,815
Inyo	23,040	Shasta	800
Kern	63,723	Siskiyou	45,407
Lake	4,500	Solano	49,711
Lassen	9,725	Sonoma	232,113
Los Angeles	971,153	Stanislaus	17,784
Madera	7,915	Sutter	6,450
Marin	104,306	Tehama	11,076
Mariposa	39,372	Trinity	1,000
Mendocino	8,275	Tulare	82,255
Modoc	200	Tuolumne	1,500
Monterey	58,623	Ventura	14,200
Napa	88,441	Yolo	300
Nevada	1,225	Yuba	42,685
Orange	3,773		
Placer	17,026	Total	$4,171,519
Plumas	1,988		

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CHAPTER FIVE.

INDUSTRIAL MATERIALS.

Bibliography: Bulletin 38. Min. & Sci. Press, Vol. 114, Mar. 10, 1917.

The following mineral substances have been arbitrarily arranged under the general heading of "Industrial Materials," as distinguished from those which have a clearly defined classification, such as metals, salines, structural materials, etc.

These materials, many of which are mineral earths, are as yet produced on a comparatively small scale. With but few exceptions the possibilities of development along these lines are practically unlimited; and with increasing transportation, and other facilities, together with a steadily growing demand, the future for this branch of the mineral industry in California is certainly promising. There is scarcely a county in the state but might contribute to the output.

Up to within the last two years, at least, production has been in the majority of instances dependent upon more or less of a strictly local market, and the annual tables show the results of such a condition, not only in the widely varying amounts of a certain material produced from year to year, but in widely varying prices of the same material, often, in different sections of the state. Furthermore, the quality of this general class of material will be found to fluctuate, even in the same deposit, especially as regards price. The war in Europe has affected some of these items, but not to the striking degree that it has the metal markets.

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The following summary shows the value of the industrial materials produced in California during the years 1915–1916, with increase or decrease in each instance:

Substance	1915		1916		Increase + Decrease — Value
	Amount	Value	Amount	Value	
Asbestos	143 tons	$2,860	145 tons	$2,380	$480—
Barytes	410 tons	620	1,606 tons	5,516	4,896+
Clay—pottery	157,863 tons	133,724	134,636 tons	146,538	12,814+
Dolomite	4,192 tons	14,504	13,313 tons	46,563	32,062+
Feldspar	1,800 tons	9,000	2,630 tons	14,350	5,350+
Fuller's earth	692 tons	4,002	110 tons	550	3,452—
Gems		3,565		4,752	1,187+
Graphite			29,190 lbs.	2,335	2,335+
Gypsum	20,200 tons	48,953	33,384 tons	59,533	10,580+
Infusorial and diatomaceous earths	12,400 tons	62,000	15,322 tons	80,649	18,649+
Limestone	146,324 tons	156,288	187,521 tons	217,733	61,445+
Lithia	91 tons	1,365	71 tons	1,065	300—
Mineral paint	311 tons	1,756	613 tons	3,960	2,204+
Mineral water	2,274,267 gals.	467,738	2,273,817 gals.	410,112	57,626—
Pumice and volcanic ash	380 tons	6,400	1,246 tons	18,092	11,692+
Pyrite	92,462 tons	293,148	120,525 tons	372,969	79,821+
Silica—sand and quartz	28,904 tons	34,322	20,880 tons	48,908	14,586+
Soapstone and talc	1,633 tons	14,750	1,703 tons	9,831	4,919—
Strontium			57 tons	2,850	2,850+
Totals		$1,254,995		$1,448,689	
Net increase					$193,694+

ASBESTOS.

Bibliography: State Mineralogist Reports XII, XIII, XIV. Bulletin 38. Canadian Dept. of M., Mines Branch, Bull. 69.

Though asbestos of various grades is known to exist widely distributed in California, the production for the year 1916 was 145 tons valued at $2,380. This was principally amphibole with some chrysotile, from Shasta County, and a small amount of chrysotile from Calaveras. For the current year, 1917, there is promise of production of chrysotile from a new deposit of good grade from Nevada County. One firm has a grinding and fiberizing plant in Oakland, and is manufacturing a series of products in which both asbestos and magnesite play a part. These include steam pipe covering, composition flooring, and plaster for stucco work. The outlook is for a decided increase in the output of these materials during the coming year.

The real history of the development and use of asbestos dates back only about sixty years. Since that time the investigation as to its occurrence, uses, and methods of treatment has been continuous, and its application to everyday life has grown with wonderful rapidity.

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The first mill built to handle the crude ore and extract the fibre on a large scale by machinery was constructed in 1888.

The first production of asbestos in California was in 1887, when 30 tons were mined, having a crude value of $60 per ton, according to the State Mining Bureau reports.

The bulk of the world's supply of this mineral today comes from Canada; and Canadian asbestos, so far, leads in quality as well as in quantity.

Classification and Characteristics.

The word "asbestos" (derived from the Greek meaning incombustible) as used here includes several minerals, from a strictly mineralogical standpoint. There are two main divisions, however; amphibole and chrysotile. The fibrous varieties of several of the amphiboles (silicates chiefly of lime, magnesia and iron), notably tremolite and actinolite, are called asbestos. Their fibres usually lie parallel to the fissures containing them. Amphibole asbestos possesses high refractory properties, but lacks strength of fibre, and is applicable principally for covering steam pipes and boilers. Chrysotile, a hydrous silicate of magnesia, is a fibrous form of serpentine, and often of silky fineness. Its fibres are formed at right angles to the direction of the fissures containing them. Chrysotile fibres, though short, have considerable strength and elasticity, and may be spun into threads and woven into cloth.

To bring the highest market price asbestos must needs have a combination of properties, *i. e.*, length and fineness of fibre, tensile strength and flexibility—all combined with infusibility. Of these qualities the most important are toughness and infusibility, and determination of the same can only be made by practical tests or in the laboratory. Given several specimens of the same tensile strength and degree of infusibility, the one having the longest fibre will, of course, be of the greatest value. It must be kept in mind, however, that length of fibre alone, the characteristic which most naturally appeals to the eye, is not the final test in regard to the commercial value of the find; and much short fibre asbestos, which on first appearance is of inferior grade, is being sold and profitably handled at the present time.

The largest Canadian asbestos deposits are worked as open quarries where the ore is roughly sorted before being sent to the mill to be dressed for the market. This method has been found to be cheaper and more satisfactory in every way.

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The milling of asbestos ore, while more or less complicated in actual practice, is easy to understand and has one well-defined object in view: That is, the complete eradication of all foreign rock ingredients and the thorough cleaning and separation of the fibres.

Asbestos, roughly speaking, was worth from $20 to $200 per ton, before the war. Under the stimulus of war conditions, the demand has caused a material increase in prices. The poorer grades which are unsuitable for weaving, and which, of course, command the lower prices, are used in the manufacture of steam packing, furnace linings, asbestos brick, wall plasters, paints, tilings, asbestos board, shingles, insulating material, etc. The better grades are utilized in the manufacture of tapestries of various kinds, fireproof theater curtains, cloth, rope, etc.

A very important development of the asbestos industry is the rapidly increasing demand for the lower grade material, on account of the numerous diversified uses to which asbestos products are being put, in almost every branch of manufacture. This fact means that many deposits of asbestos will become commercially important even though the grade of the material is far from the best.

It has been discovered only recently that not only does an asbestos wall plaster render the wall so covered impervious to heat, but that in rooms which have given forth an undesirable echo this evil has been absolutely removed. Asbestos pulp mixed with cement and magnesite has been experimented with; and roofing, flooring, and other building material of the most satisfactory sort has been manufactured therefrom.

Value and Production.

The value of the domestic production of asbestos has averaged around $43,000 annually, the past ten years, except 1911, which was approximately $120,000. In 1916, according to the U. S. Geological Survey, this increased to 1,479 tons worth $448,214. The imports, largely from Canada, for 1916 amounted to 116,162 tons valued at $3,303,470. This value is for crude material; adding the imported manufactured asbestos articles the figure amounts to $3,438,534.

With the field for development along these lines which is open in California, it seems almost certain that some time in the future will see this branch of the mineral industry adding an important share to the total of the wealth and productiveness of this state.

Total amount and value of asbestos production in California since 1887, as given in the records of this Bureau, are as follows:

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Year	Tons	Value	Year	Tons	Value
1887	30	$1,800	1903		
1888	30	1,800	1904	10	$162
1889	30	1,800	1905	112	2,625
1890	71	4,260	1906	70	3,500
1891	66	3,960	1907	70	3,500
1892	30	1,830	1908	70	6,100
1893	50	2,500	1909	65	6,500
1894	50	2,250	1910	200	20,000
1895	25	1,000	1911	125	500
1896			1912	90	2,700
1897			1913	47	1,175
1898	10	200	1914	51	1,530
1899	30	750	1915	143	2,860
1900	50	1,250	1916	145	2,380
1901	110	4,400			
1902			Totals	1,780	$81,332

BARYTES.

Bibliography: State Mineralogist Reports XII, XIV. Bulletin 38.

The output of crude barytes during 1916 was 1,606 tons, valued at $5,516, from Mariposa and Monterey counties, as compared with the 1915 production of 410 tons, worth $620. This mineral is ordinarily sorted and ground before being put on the market, and in this prepared condition brings from $10 to $15 per ton. The principal use of barytes is in the paint industry. Minor uses are in tanning of leather, manufacture of paper and rope, and sugar refining. A grinding and chemical plant is in operation at Melrose, Alameda County, making a specialty of barium compounds; and another at South San Francisco.

Known occurrences of this mineral in California are located in Inyo, Los Angeles, Mariposa, Monterey, San Bernardino, and Santa Barbara counties. The deposit at El Portal, in Mariposa County, has given the largest commercial production to date. The tonnage above recorded is in part, witherite (barium carbonate, $BaCO_3$) from El Portal. The 1915 output was the first commercial production of the carbonate in the United States, of which we have record. The El Portal witherite and barite are both high grade. In 1916, output began from a new deposit being opened up on Fremont's Peak, Monterey County, near the line of San Benito County.

The first recorded production of barytes in California, according to the statistical reports of the State Mining Bureau, was in 1910. The annual figures are as follows:

Year	Tons	Value	Year	Tons	Value
1910	860	$5,640	1915	410	$620
1911	309	2,207	1916	1,606	5,516
1912	564	2,812			
1913	1,600	3,680			
1914	2,000	3,000	Totals	7,349	$23,475

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CLAY—POTTERY.

Bibliography: State Mineralogist Reports I, IV, IX, XII, XIII, XIV. Bulletin 38.

At one time or another in the history of the state, pottery clay has been quarried in thirty-three of its counties. In this report "pottery clay" refers to all clays used in the manufacture of red and brown earthenware, flower pots, ornamental tiling, architectural terra cotta, sewer pipe, etc., and the figures for amount and value are relative to the crude material at the pit, without reference to whether the clay was sold in the crude form, or whether it was immediately used in the manufacture of any of the above finished products by the producer. It does not include clay used in making brick and building blocks.

During 1916 producers in 15 counties reported an output of 134,636 tons of clay, having a spot value of $146,538 for the crude material, at the pits, as compared with the 1915 production of 157,866 tons worth $133,141.

A tabulation of the direct returns from the producers, by counties, for the year 1916, is shown herewith:

County	Tons	Value	Used in manufacture of—
Alameda	4,060	$2,750	Sewer pipe, roofing tile.
Amador	[1]29,246	31,106	Fire-clay products, sewer and chimney pipe, architectural terra cotta, porcelain, stoneware, pottery, sanitary ware.
Los Angeles	[2]6,233	10,549	Terra cotta, sewer pipe, chimney pipe, roofing tile.
Placer	29,018	36,230	Terra cotta, roofing et al. tile, sewer and chimney pipe, architectural terra cotta, sanitary ware.
Riverside	56,228	56,090	Sewer pipe, pottery, terra cotta, etc.
San Diego	[3]283	613	Art pottery and tile.
San Mateo	[4]593	732	Various.
Santa Clara	2,024	2,293	Flower pots, chimney pipe.
Contra Costa, Fresno, Kern, Orange, Sacramento, San Luis Obispo, Ventura.*	6,951	6,175	Chimney and vitrified sewer pipe, stoneware, porcelain, drain, roof, floor and faience tile.
Totals	134,636	$146,538	

*Combined to conceal output of a single operator in each.
[1]Includes kaolin; also "fire sand" used in making fire brick.
[2]Includes modeling clay; also ground brick and clay.
[3]Includes crushed tile and brick.
[4]Includes modeling clay.

Because of the fact that a given product often requires a mixture of several different clays, and that these are not all found in the same pit,

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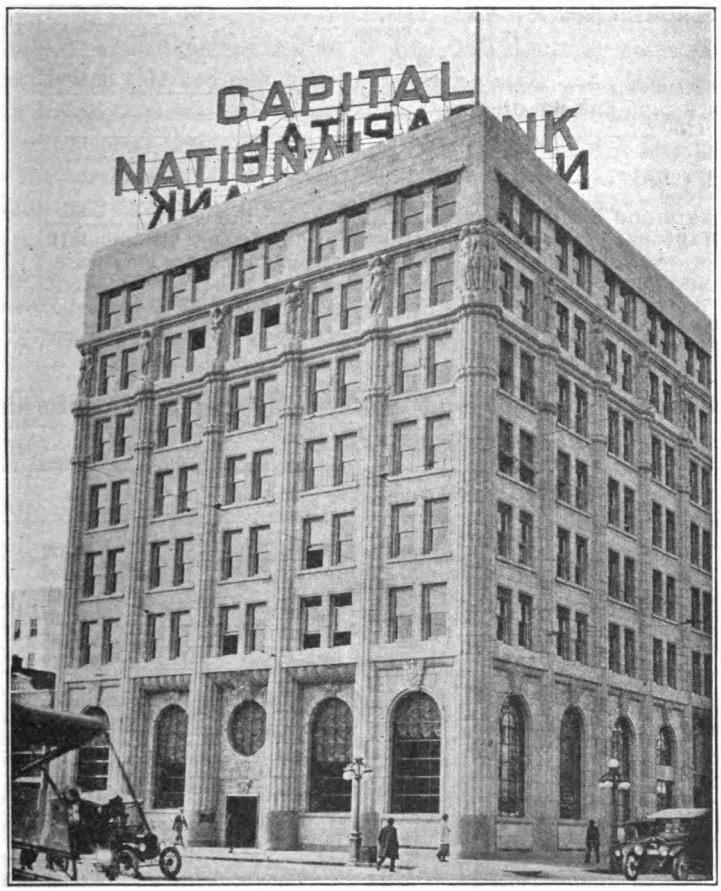
it is necessary for most clay-working plants to buy some part of their raw materials from other localities. For these reasons, in compiling the clay industry figures, much care is required to avoid duplications. The new form of clay blank sent out by the State Mining



Capital National Bank Building, Sacramento, finished with architectural terra cotta from Steiger Terra Cotta & Pottery Works. Clay from pits in Amador and San Mateo counties.

Bureau, this year, and the coöperation of the operatives in filling it out, has enabled us to make a more intelligent compilation of the data than heretofore, both as to sources of the crude material and as to kinds and values of the manufactured articles. So far as we have been able to segregate them, we have credited the clay output to the counties from which the raw material originated.

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The values of the various pottery clay products made in California during 1916, totaled $1,844,474, their distribution being shown in the following tabulation:

Values of Pottery Clay Products, 1916.

Product	Value
Architectural terra cotta	$341,600
Chimney pipe and flue linings	51,197
Drain tile	108,260
Roofing tile	129,945
Sanitary ware	332,029
Sewer pipe	702,351
Stoneware and red earthenware	74,872
Miscellaneous—including art pottery, floor and faience tile, conduit ducts, lead corroding pots, chemical ware, gas logs, fire clay ware, vases and garden furniture	104,220
Total	$1,844,474

Amount and value of crude pottery clay output in California since 1887 are given in the following table:

Year	Tons	Value	Year	Tons	Value
1887	75,000	$37,500	1903	90,972	$99,907
1888	75,000	37,500	1904	84,149	81,952
1889	75,000	37,500	1905	133,805	130,146
1890	100,000	50,000	1906	167,267	162,283
1891	100,000	50,000	1907	160,385	254,454
1892	100,000	50,000	1908	208,042	325,147
1893	24,856	67,284	1909	299,424	465,647
1894	28,475	35,073	1910	249,028	324,099
1895	37,660	39,685	1911	224,576	252,759
1896	41,907	62,900	1912	199,605	215,683
1897	24,592	30,290	1913	231,179	261,273
1898	28,947	33,747	1914	179,948	167,552
1899	40,600	42,700	1915	157,866	133,724
1900	59,636	60,956	1916	134,636	146,538
1901	55,679	39,144			
1902	67,933	74,163	Totals	3,456,167	$3,769,606

DOLOMITE.

Bibliography: Bulletin 67.

In the 1915 report, dolomite was for the first time made the subject of a separate classification. Previously it had been included under limestone. Limestones are frequently more or less magnesian-bearing, and a chemical analysis is often necessary to definitely decide as to whether they are calcite or dolomite; the latter standing intermediate between magnesite ($MgCO_3$) and calcite ($CaCO_3$). Since dolomite,

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as such, has been found to have certain distinctive applications, we have deemed it worthy of a separate classification.

The major portion of the tonnage shipped in 1915 and 1916 was utilized as a refractory lining in open-hearth steel furnaces, as a partial substitute for magnesite. A portion was used for its carbonic acid gas (CO_2), and part for its magnesia. We are also informed that one company with quarries in San Benito and Monterey counties proposes to furnish calcined dolomite to the paper mills. As this dolomite has been found to contain the proper proportions of lime and magnesia, it could replace an artificial mixture of calcined limestone and magnesite in the manufacture of paper from wood pulp. Dolomite is also sometimes used as a flux in metal smelting.

The production of dolomite for the year 1916 amounted to 13,313 tons, valued at $46,566, and came from a total of six quarries in four counties distributed as follows:

County	Tons	Value
Inyo	3,596	$14,700
San Benito	8,100	25,515
San Bernardino and Tuolumne*	1,617	6,351
Totals	13,313	$46,566

*Combined to conceal output of a single operator in each.

Amount and value of the output of dolomite, annually, have been as follows:

Year	Tons	Value
1915	4,192	$14,504
1916	13,313	46,566
Totals	17,505	$61,070

FELDSPAR.

Bibliography: Bulletin 67. U. S. Bur. of M., Bull. 92.

Feldspar was produced by one operator each in Kern, Monterey, Riverside, San Bernardino and Tulare counties during 1916, to the amount of 2,630 tons, valued at $14,350. Feldspar production only dates back to 1910 in this state. The mineral is a constituent of many rocks, but can only be commercially produced from pegmatites where the crystals are large and quite free from impurities. The open cut method of mining this material is commonly used. Manufacturers of

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enamel wares and pottery buy most of the better grades of feldspar produced. Small quantities are used in the manufacture of glass and scouring soaps, and the more impure material is utilized as "chicken grit," in making various brands of roofing, and in other ways. Various experiments have been made with the potash feldspars in the attempt to extract their potash content for use in fertilizers. Some recent successes along these lines are enumerated under Potash.

Total amount and value of feldspar production in California since the inception of the industry are given in the following table, by years:

Year	Tons	Value	Year	Tons	Value
1910	760	$5,720	1915	1,800	$9,000
1911	740	4,560	1916	2,630	14,350
1912	1,382	6,180			
1913	2,129	7,850			
1914	3,530	16,565	Totals	12,971	$64,220

FULLER'S EARTH.

Bibliography: Bulletin 38. U.-S. Bur. of M., Bull. 71.

Fuller's earth production in California during the year 1916 amounted to 110 tons, valued at $550, as compared with 692 tons valued at $4,002, in 1915.

This material is soft and friable, and, in general, resembles a clay, but is non-plastic. It has no definite mineralogical composition, and its commercial value is determined by its physical properties, *i. e.*, texture, and filtering and absorbent properties.

In California, fuller's earth is used in clarifying both refined mineral and vegetable oils, although its original use was in fulling wool, as the name indicates. During 1916 the production came from Fresno and Kern counties. A large deposit of high-grade fuller's earth has been found near Elsinore in Riverside County. Some has also come from Solano County.

It was first produced commercially in this state in 1899, and the total amount and value of the output since that time are as follows:

Year	Tons	Value	Year	Tons	Value
1899	620	$12,400	1909	459	$7,385
1900	500	3,750	1910	340	3,820
1901	1,000	19,500	1911	466	5,294
1902	987	19,246	1912	876	6,500
1903	250	4,750	1913	460	3,700
1904	500	9,500	1914	760	5,928
1905	1,344	38,000	1915	692	4,002
1906	440	10,500	1916	110	550
1907	100	1,000			
1908	50	1,000	Totals	9,954	$156,825

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FLUORSPAR.

Bibliography: Bulletin 67.

Fluorspar is used as a flux in steel and iron smelting, and in the production of aluminum. It is also utilized in the manufacture of hydrofluoric acid, glass, porcelain, enamels and sanitary ware.

In California, deposits have been reported in Los Angeles, Mono and San Bernardino counties, but as yet no commercial production has resulted.

GEMS.

Bibliography: State Mineralogist Reports II, XIV. Bulletins 37, 64, 67.

Accounting for the production of gems in California is somewhat unsatisfactory, owing to the widely scattered places at which stones are gathered and marketed in a very small way. The following table shows the production, by counties, of rough uncut materials during 1916:

County	Value	Kind
Butte	$357	Diamonds.
Los Angeles	600	Beach stones.
San Bernardino	1,000	Bloodstone and blue chalcedony.
San Diego	2,710	Beryl, golden beryl, hyacinth, kunzite, tourmalines, green topaz, smoky and white quartz crystals.
San Mateo	85	Beach stones.
Total value	$4,752	

California tourmalines are decidedly distinctive in coloring and "fire" as compared to foreign stones of this classification. The colors range from deep ruby to pink, and various shades of green; also more recently a blue tourmaline has been found.

Two of our California gem stones, kunzite and benitoite, are not found elsewhere in the world; and these, each in but a single locality here: the former in the Pala Chief Mine in San Diego County, and the latter in the Dallas Mine in San Benito County.

Some rhodonite was taken out in Siskiyou County in 1915, and used for decorative purposes, its value being included in the marble figures.

Diamonds have been found in a number of localities in California; but in every case, they have been obtained in stream gravels while working them for gold. The principal districts have been: Volcano in Amador County; Placerville, Smith's Flat and others in El Dorado County; French Corral, Nevada County; Cherokee Flat and Yankee Hill, Butte County; Gopher Hill and upper Spanish Creek, Plumas County. The most productive district of recent years has been Cherokee

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in Butte County. In 1916, in addition to several smaller ones, a two-carat stone was found, which after cutting was stated to have been valued at $450.

The value of the total gem production in California annually since the beginning of commercial production is as follows:

Year	Value	Year	Value
1900	$20,500	1910	$237,475
1901	40,000	1911	51,824
1902	162,100	1912	23,050
1903	110,500	1913	13,740
1904	136,000	1914	3,970
1905	148,500	1915	3,565
1906	497,090	1916	4,752
1907	232,642		
1908	208,950	Total	$2,088,358
1909	193,700		

GRAPHITE.

Bibliography: State Mineralogist Reports XIII, XIV. Bulletin 67. U. S. G. S., Min. Res. 1914, Pt. II.

Graphite has been produced from time to time in the state, coming principally from Sonoma County, and was used in paint manufacture. It is difficult for these deposits, which are not particularly pure, to compete with foreign supplies which go on the market almost directly as they come from the deposit.

The annual graphite production of the United States previous to 1915 amounted to about $250,000, while the yearly imports had a value of approximately two million dollars. These facts show the possibilities which are open to this branch of the mineral industry, provided, of course, that investigation would show sufficient amounts of high-grade material to compete with the imported article, which at the present time comes largely from Ceylon. Low-grade ores are concentrated with considerable difficulty and the electric process of manufacturing artificial graphite from coal has been perfected to such a degree that only deposits of natural graphite of a superior quality can be exploited with any certainty of success.

On account of its unfusibility and resistance to the action of molten metals, graphite is very valuable. It is also largely used in the manufacture of electrical appliances, of "lead" pencils, as a lubricant, as stove polish, and in many other ways. Amorphous graphite, commonly carrying many impurities, brings a much lower price. For some pur-

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poses, such as foundry facings, etc., the low-grade material is satisfactory. The price increases with the grade of the material until the best quality crystalline variety, ranges as high as $200 per ton. Because of the present increased demand for brass and crucible steel, the requirement for graphite crucibles has gone up rapidly, thus boosting the price of flake graphite to above $400 per ton for Ceylon lumps. The coarser flakes are necessary for crucibles as they help to bind the clay together in addition to their refractory service.

Among the newer uses for graphite is the prevention of formation of scale in boilers. The action is a mechanical one. Being soft and slippery, the graphite prevents the particles of scale from adhering to one another or to the boiler and they are thus easily removed.

Occurrence of graphite has been reported at various times from Calaveras, Fresno, Imperial, Los Angeles, Mendocino, San Bernardino, San Diego, Siskiyou, Sonoma and Tuolumne counties.

During 1916 production was reported to the amount of 15 tons, worth $2,335. It was concentrated from a disseminated ore, and was used for paint, foundry facing, and lubricants. The production, by years, has been as follows:

Year	Pounds	Value
1901	128,000	$4,480
1902	84,000	1,680
1903	----------	----------
1913	2,500	25
1914	----------	----------
1915	----------	----------
1916	29,190	2,335
Totals	243,690	$8,520

GYPSUM.

Bibliography: Bulletins 38, 67. Report XIV.

Gypsum is widely distributed throughout the state, and is produced to a considerable extent, to supply the fertilizer manufacturers and those of plaster and cement. One producer reported orders for shipment to Honolulu, for fertilizer purposes.

During 1916, six producers in Inyo, Riverside and San Bernardino counties took out a total of 33,384 tons, valued at $59,533. The increase over the 20,200 tons, valued at $48,953 in 1915 is due principally to the entry of a new plant in Inyo County, besides a fair increase in the output of the older plants in San Bernardino and Riverside counties.

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Total annual production of gypsum in California since such records have been compiled by this Bureau is as follows:

Year	Tons	Value	Year	Tons	Value
1887	2,700	$27,000	1903	6,914	$46,441
1888	2,500	25,000	1904	8,350	56,592
1889	3,000	30,000	1905	12,850	54,500
1890	3,000	30,000	1906	21,000	69,000
1891	2,000	20,000	1907	8,900	57,700
1892	2,000	20,000	1908	34,600	155,400
1893	1,620	14,280	1909	30,700	138,176
1894	2,446	24,584	1910	45,294	129,152
1895	5,158	51,014	1911	31,457	101,475
1896	1,310	12,580	1912	37,529	117,388
1897	2,200	19,250	1913	47,100	135,050
1898	3,100	23,600	1914	29,734	78,375
1899	3,663	14,950	1915	20,200	48,953
1900	2,522	10,088	1916	33,384	59,533
1901	3,875	38,750			
1902	10,200	53,500	Totals	419,306	$1,662,331

INFUSORIAL and DIATOMACEOUS EARTH.

Bibliography: State Mineralogist Reports II, XII, XIII, XIV. Bulletins 38, 67.

Infusorial and diatomaceous earths—sometimes called tripolite—are very light and extremely porous, chalk-like materials composed of pure silica (chalk, being calcareous) which has been laid down under water and consist of the remains of microscopical infusoria and diatoms. The former are animal remains, and the latter are from plants. Their principal commercial use is as an absorbent; and it is also employed in the manufacture of scouring soap and polishing powders, and in making some classes of refractory brick. It is a first-class nonconductor of heat, where high temperatures are employed, such as around steel and gas plants and power houses. In such cases, it is built in as an insulating layer in furnace walls. In Germany, under the same "kieselguhr," it is used as an absorbent for nitroglycerine in the manufacture of dynamite.

The most important deposits in California thus far known are located in Monterey, Orange, San Luis Obispo, and Santa Barbara counties. The Santa Barbara material is diatomaceous and is of a superior quality. Infusorial earth is also found in Fresno, Kern, Los Angeles, Plumas, San Benito, San Bernardino, San Joaquin, Shasta, Sonoma, and Tehama counties.

During 1916, there were three actively operated quarries in Monterey and Santa Barbara counties, which produced a total of 15,322 tons, valued at $80,649, conpared with 12,400 tons, valued at 62,000, in 1915.

It will be noted that the average price varies widely from year to year. This fact is true in case of many of the industrial materials.

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The quality of the product fluctuates as does the demand; when both are favorable the maximum price obtains.

The first recorded production of these materials in California occurred in 1889; total amount and value of output, to date, are as follows:

Year	Tons	Value	Year	Tons	Value
1889	39	$1,335	1904	6,950	$112,282
1890			1905	3,000	15,000
1891			1906	2,430	14,400
1892			1907	2,531	28,948
1893	50	2,000	1908	2,950	32,012
1894	51	2,040	1909	500	3,500
1895			1910	1,843	17,617
1896			1911	2,194	19,670
1897	5	200	1912	4,129	17,074
1898			1913	8,645	35,968
1899			1914	12,840	80,350
1900			1915	12,400	62,000
1901			1916	15,322	80,649
1902	422	2,532			
1903	2,703	16,015	Totals	79,004	$543,592

LIMESTONE.

Bibliography: State Mineralogist Reports IV, XII, XIII, XIV. Bulletin 38.

Limestone was produced in 12 counties during 1916, to the amount of 187,521 tons, valued at $217,733. This amount does not include the limestone used in the manufacture of cement nor of lime for building purposes, but accounts for that utilized as a smelter flux, for sugar making, and in other chemical and manufacturing processes (including fertilizers, roofing preparations, whiting for paint, terrazzo and for CO_2). The marked drop in the 1915 output as compared with the 1914 figures, was due in part to our transferring to the macadam classification a large tonnage of limestone employed as road metal; but which in the 1914 report was classified as "industrial" limestone. The 1916 output shows a material increase over 1915.

Distribution of the 1916 output is as follows:

County	Tons	Value
Kern	3,402	$3,947
San Bernardino	65,174	63,486
Santa Cruz	4,318	9,820
Shasta	51,931	51,737
Tuolumne	3,137	5,132
Alameda, Contra Costa, El Dorado, Placer, Santa Barbara, Santa Clara, Tulare*	59,559	83,611
Totals	187,521	$217,733

*Combined to conceal output of a single operator in each.

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In the early reports of this Bureau values for lime and limestone were not segregated. The following tabulation shows the total combined value of such material since records for the state were first compiled, in 1887, to date:

Year	Value	Year	Value
1887	$368,750	1903	$582,268
1888	381,750	1904	658,956
1889	416,780	1905	878,647
1890	350,000	1906	925,887
1891	300,000	1907	1,162,417
1892	300,000	1908	676,507
1893	301,276	1909	997,745
1894	337,975	1910	1,058,891
1895	457,784	1911	843,778
1896	332,617	1912	1,034,688
1897	291,465	1913	803,002
1898	278,558	1914	896,376
1899	343,760	1915	442,592
1900	315,231	1916	608,208
1901	434,133		
1902	460,140	Total	$17,240,181

LITHIA.

Bibliography: State Mineralogist Reports II, IV, XIV. Bulletins 38, 67.

Lithia mica, lepidolite (a silicate of lithium *et al.*) utilized in the manufacture of artificial mineral water, fireworks, etc., was mined and sold in San Diego County during the years 1899–1905 inclusive, but there was no commercial production from the latter date, until 1915. Some amblygonite, a lithium phosphate, has also been obtained from pockets associated with the gem tourmalines. In 1916, the yield of lepidolite was 71 tons, valued at $1,065, and was utilized in glass manufacture.

The following table of analyses shows the composition of some of the lithia minerals:

Analyses of Lithia Minerals.[17]

	Amblygonite, Pala, Cal. (per cent)	Lepidolite, Pala, Cal. (per cent)	Spodumene, Goshen, Mass. (per cent)	Spodumene, Branchville Mass. (per cent)	Lepidolite, Paris, Maine (per cent)
Lithia (Li_2O)	8.26	4.91	6.89	7.62	4.20
Silica (SiO_2)	1.99	48.61	63.27	64.25	50.92
Phosphoric acid (P_2O_5)	45.47	----	----	----	----
Alumina (Al_2O_3)	33.09	22.36	23.73	27.20	24.99
Iron oxide (FeO)	Trace	----	1.17	.20	.23
Potash (K_2O)	----	16.16	1.45	----	11.38
Soda (Na_2O)	----	.38	.99	.39	2.11
Loss on ignition, water, etc.	6.28	----	.36	.24	1.96
Undetermined	3.56	----	----	----	----
Lime (CaO)	1.35	.64	.11	----	----
Magnesia (MgO)	----	----	2.02	----	----
Fluorine	----	2.05	----	----	6.29

[17]Bulletin No. 38, p. 308.

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Lithia mica total production in the state has been as follows:

Year	Tons	Value	Year	Tons	Value
1899	124	$4,600	1905	25	$276
1900	440	11,000	1906		
1901	1,100	27,500	1915	91	1,365
1902	822	31,880	1916	71	1,065
1903	700	27,300			
1904	641	25,000	Totals	4,014	$129,986

MICA.

Bibliography: State Mineralogist Reports II, IV. Bulletins 38, 67.

No production of mica has recently been reported. Production in previous years has been as follows:

Year	Tons	Value
1902	50	$2,500
1903	50	3,800
1904	50	3,000
Totals	150	$9,300

MINERAL PAINT.

Bibliography: State Mineralogist Reports XII, XIII, XIV. Bulletin 38.

Mineral paint was produced in California in 1916 from Colusa, San Bernardino and Stanislaus counties, amounting to 643 tons, valued at $3,960. This is a little more than double the tonnage and value of 1915. The material from the first two named was hematite and jasper, while that from Stanislaus was yellow ochre. The Stanislaus and Calaveras ochres are the equal of any of the imported ochres.

Besides the above-named counties, deposits of mineral paint are located in the following: Kern, Kings, Lake, Los Angeles, Nevada, Riverside, and Sonoma.

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The first recorded production of this material in the state was in the year 1890. The output showing annual amount and value, since that time, is given herewith:

Year	Tons	Value	Year	Tons	Value
1890	40	$480	1905	754	$4,025
1891	22	880	1906	250	1,720
1892	25	750	1907	250	1,720
1893	590	26,795	1908	335	2,250
1894	610	14,140	1909	305	2,325
1895	750	8,425	1910	200	2,040
1896	395	5,540	1911	186	1,184
1897	578	8,165	1912	300	1,800
1898	653	9,698	1913	303	1,780
1899	1,704	20,294	1914	132	847
1900	529	3,993	1915	311	1,756
1901	325	875	1916	643	3,960
1902	589	1,533			
1903	2,370	3,720			
1904	270	1,985	Totals	13,419	$132,680

MINERAL WATER.

Bibliography: State Mineralogist Reports VI, XII, XIII, XIV. U. S. G. S., Water Supply Paper 338.

A widespread production of mineral water is shown annually in California. These figures refer to mineral water actually bottled for sale, or for local consumption. Water from some of the springs having a special medicinal value brings a price many times higher than the average shown, while in some cases the water is used merely for drinking purposes and sells for a nominal figure. Health and pleasure resorts are located at many of the springs. The waters of some of the hot springs are not suitable for drinking, but are very efficacious for bathing. From a therapeutic standpoint, California is particularly rich in mineral springs. The counterparts of practically any of the world-famed spas of Europe or the eastern United States can be found here.

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Commercial production, by counties, for 1916 was:

County	Gallons	Value
Butte	3,150	$1,125
Calaveras	18,255	7,025
Contra Costa	351,724	6,154
Humboldt	3,000	750
Lake	195,650	54,160
Los Angeles	320,700	8,552
Monterey	5,900	590
Napa	152,764	93,370
San Bernardino	40,500	6,500
San Luis Obispo	2,500	475
Santa Barbara	176,608	110,200
Santa Clara	50,000	11,300
Siskiyou	502,650	50,530
Solano	11,200	3,750
Sonoma	121,366	28,031
Colusa, Fresno, Marin, Riverside, San Benito, San Diego, Shasta, Tehama, Trinity*	317,850	27,600
Totals	2,273,817	$410,112

*Combined to conceal output of a single operator in each.

Amount and value of mineral water produced in California since 1887 are given herewith:

Year	Gallons	Value	Year	Gallons	Value
1887	618,162	$144,368	1903	2,056,340	$558,201
1888	1,112,202	252,990	1904	2,430,320	496,946
1889	808,625	252,241	1905	2,194,150	538,700
1890	258,722	89,786	1906	1,585,690	478,186
1891	334,553	139,959	1907	2,924,269	544,016
1892	331,875	162,019	1908	2,789,715	560,507
1893	383,179	90,667	1909	2,449,834	465,488
1894	402,275	184,481	1910	2,335,259	522,009
1895	701,397	291,500	1911	2,637,669	590,654
1896	808,843	337,434	1912	2,497,794	529,384
1897	1,508,192	345,863	1913	2,350,792	599,748
1898	1,429,809	213,817	1914	2,443,572	476,169
1899	1,338,537	406,691	1915	2,274,267	467,738
1900	2,456,115	268,607	1916	2,273,817	410,112
1901	1,555,328	559,057			
1902	1,701,142	612,477	Totals	48,992,444	$11,589,815

PHOSPHATES.

Bibliography: Bulletin 67.

No commercial production of phosphates has been recorded from California, though occasional pockets of the lithia phosphate, amblygonite, Li (AlF) PO_4, have been found associated with the gem tourmaline deposits in San Diego County. Such production has been classified under lithia.

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PUMICE and VOLCANIC ASH.

Bibliography: State Mineralogist Reports XII, XIV (see "Tufa"). Bulletin 38.

The production of pumice and volcanic ash for the year 1916 amounted to 1,246 tons, valued at $18,092, and came from Imperial and San Bernardino counties. The material from Imperial County is the vesicular, block pumice, this being practically the only locality in the United States producing this class of rock at the present time; and is stated to have found a ready market. The Lipari Islands, Italy, have in the past been the principal source of supply of block pumice, but now largely shut off owing to the European war. There are other known deposits of such pumice in California, in Inyo, Madera, Mono and Siskiyou counties, but not at present utilized. The material shipped from Inyo and Madera counties in 1915 was the fine-grained, volcanic ash of tuff variety. It is employed in making scouring soaps and polishing powders.

Commercial production of pumice in California was first reported to the State Mining Bureau in 1909, then not again until 1912, since which year there has been a small annual output, as indicated by the following table:

Year	Tons	Value	Year	Tons	Value
1909	50	$500	1914	50	$1,000
1910			1915	380	6,400
1911			1916	1,246	18,092
1912	100	2,500			
1913	3,590	4,500	Totals	5,416	$32,992

PYRITE.

Bibliography: Bulletin 38. Min. & Sci. Press, Vol. 114, pp. 825, 840.

Pyrite is mined for use in the manufacture of sulphuric acid. Experiments are being made as to the effect of sulphur, sulphuric acid, and SO_2 in the correction and fertilization of alkali soils. Two properties in Alameda County and one in Shasta report a total production in 1916 of 120,525 tons, valued at $372,969. This is the largest output in tonnage of any year except 1909, and in value except 1908 and 1909.

This does not include the vast quantities of pyrite which are otherwise treated for their valuable metal contents.

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The total production in California to date is as follows:

Year	Tons	Value	Year	Tons	Value
1898	6,000	$30,000	1909	457,867	$1,389,802
1899	5,400	28,620	1910	42,621	179,862
1900	3,642	21,133	1911	54,225	182,954
1901	4,578	18,429	1912	69,872	203,470
1902	17,525	60,306	1913	79,000	218,537
1903	24,311	94,000	1914	79,267	230,058
1904	15,043	62,992	1915	92,462	293,148
1905	15,503	63,958	1916	120,525	372,969
1906	46,689	145,895			
1907	82,270	251,774	Totals	1,323,881	$4,458,292
1908	107,081	610,335			

SILICA—SAND and QUARTZ.

Bibliography: State Mineralogist Reports IX, XIV. Bulletins 38, 67.

We combine these materials, because of the overlapping roles of vein quartz which is mined for use in glass making and as an abrasive, and that of silica sand which, although mainly utilized in glass manufacture, also serves as an abrasive.

A portion of the tonnage of vein quartz in 1916 was employed in the preparation of ferro-silicon by the electric furnace. Some also was utilized as a foundry flux.

The production of silica in 1916 amounted to 20,880 tons, valued at $48,908, from 13 properties in Amador, El Dorado, Kern, Los Angeles, Monterey, Riverside, Shasta and Tulare counties. The decrease in quantity is due to a considerable falling off in the output of Amador County. The increased value is the result of the higher price reported for the Kern County product.

County	Tons	Value
Amador	4,341	$12,802
El Dorado	886	1,717
Kern	4,100	23,700
Los Angeles	612	1,684
Riverside	901	1,642
Monterey, Shasta, Tulare*	10,040	7,363
Totals	20,880	$48,908

*Combined to conceal output of a single operator in each.

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Of the above total, 4,202 tons were of vein and boulder quartz, and 16,678 tons, sand.

Practically all the glass sand produced in California occurs as such and needs no grinding. There are various deposits of quartz which could be utilized for glass making, but to date there has been only a small commercial production of this class of material.

Glass sand has been produced in the following counties of the state: Alameda, Amador, El Dorado, Los Angeles, Monterey, Orange, Placer, Riverside, San Joaquin, and Tulare. The chief producing centers have been Amador, Monterey and Los Angeles counties. The industry is of limited importance, so far, because of the fact that much of the available material is not of a grade which will produce first-class glass. High-grade deposits are known, but transportation facilities in most cases are so poor that the owners are unable to compete with the foreign sand which is brought in as ballast and sold at a low price.

Total silica production in California since the inception of the industry, in 1899, is shown below, being mainly glass sand:

Year	Tons	Value	Year	Tons	Value
1899	3,000	$3,500	1909	12,259	$25,517
1900	2,200	2,200	1910	19,224	18,265
1901	5,000	16,250	1911	8,620	8,672
1902	4,500	12,225	1912	13,075	15,404
1903	7,725	7,525	1913	18,618	21,899
1904	10,004	12,276	1914	28,538	22,688
1905	9,257	8,121	1915	28,904	34,322
1906	9,750	13,375	1916	20,880	48,908
1907	11,065	8,178			
1908	9,255	22,045	Totals	221,874	$301,370

SOAPSTONE or TALC.

Bibliography: State Mineralogist Reports XII, XIV. Bulletins 38, 67.

Soapstone—also called talc or steatite—occurs widely distributed throughout California. It is found as a hydration product in the alteration of magnesian silicates, and is often associated with serpentine and actinolite. But few deposits have been proven of especial value to date, although there is an undoubted future for this branch of the mineral industry in the state. Deposits of high grade white talc, the equal of the imported Italian article, are now being developed in Inyo and San Bernardino counties. It is used in making paper, toilet articles, soap, lubricants, tiling, etc., and for such is ordinarily ground to about 200 mesh before marketing. In this condition it brings $15 per ton and upwards, depending on quality. Commercially, the higher grades

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are called talc, and the lower, soapstone. Soapstone blocks are used in fireless cookers, and the crushed material is used in roofing papers.

There was a total output in 1916 of 1,703 tons, valued at $9,831, from two producers each in Amador and Inyo counties and one each in El Dorado and San Bernardino counties, divided as follows:

County	Tons	Value
Amador	495	$2,475
Inyo	658	4,606
El Dorado and San Bernardino*	550	2,750
Totals	1,703	$9,831

*Combined to conceal output of a single mine in each.

Production has been intermittent in the state since 1893, as shown in the following table:

Year	Tons	Value	Year	Tons	Value
1893	400	$17,750	1906		
1894			1907		
1895	25	375	1908	3	$48
1896			1909	33	280
1897			1910	740	7,260
1898			1911		
1899			1912	1,750	7,350
1900			1913	1,350	6,150
1901	10	119	1914	1,000	4,500
1902	14	288	1915	1,663	14,750
1903	219	10,124	1916	1,703	9,831
1904	228	2,315			
1905	300	3,000	Totals	9,438	$84,140

STRONTIUM.

Bibliography: Bulletin 67. U. S. G. S., Bull. 540.

Production of strontium minerals in California in 1916 amounted to 57 tons, worth $2,850, from Imperial and San Bernardino counties. That from the former is celestite ($SrSO_4$), while that from near Barstow in San Bernardino County is the carbonate, strontianite ($SrCO_3$). This is the first recorded commercial output of strontium minerals in California. The occurrence of the carbonate is particularly interesting and valuable, as it appears to be the first considerable deposit of commercial importance so far opened up in the United States. Shipments reported as averaging 80% $SrCO_3$ are being made. The deposit is associated with deposits of barite.

In addition to the Imperial County occurrence above noted, celestite is also found near Calico, and in the Avawatz Mountains in San Bernardino County, but as yet undeveloped. The above output was converted

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to the nitrate, which has been quoted recently at prices in excess of $450 per ton, f. o. b. eastern points.

It is estimated by the U. S. Geological Survey, that prior to 1914 about 2,000 tons of strontium nitrate was used in the manufacture of flares, or Costen and Bengal lights and fireworks. The demand has since increased considerably. Previously, the nitrate was imported from Germany, England and Sicily.

There is undoubtedly a good future for the strontium minerals in California, if the beet-sugar factories will take up their use, as has been done in Germany. Strontia is much more efficient and satisfactory in that process than lime, as it is stated to give an additional recovery of 6%–8% over lime. In Germany and Russia, about 100,000 tons of strontium hydroxide are used annually in the sugar industry.

Of the two minerals, strontianite is the more desirable, but scarcer. Celestite is more abundant, and can be sold in large quantities at about $12–$14 per ton at the Atlantic seaboard. Celestite is found with limestones and sandstones and is sometimes associated with gypsum. Strontianite is also found with limestone, but associated with barite and calcite.

SULPHUR.

Bibliography: State Mineralogist Reports IV, XIII, XIV. Bulletins 38, 67.

There is, at present, no commercial output of native sulphur in California although this mineral has been found to some extent in Colusa, Imperial, Inyo, Kern, Lake, Mariposa, San Bernardino, Sonoma, Tehama, and Ventura counties. Production of sulphur seems improbable in the immediate future, although possibilities of such a condition remain to be proven.

Sulphur was produced at the famous Sulphur Bank mine, in Lake County, during the years 1865–1868 (inc.), totaling 941 tons, valued at $53,500; following which the property became more valuable for its quicksilver. There has been no commercial yield of sulphur in California since that period.

About 37,000 tons of sulphur per year are imported to the United States from Japan, most of it coming in through the port of San Francisco.

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CHAPTER SIX.

SALINES.

Under this heading are included borax, common salt, soda, potash and other alkaline salts. The first two have been produced in a number of localities in California, more or less regularly since the early sixties, although the State Mining Bureau kept no annual records of output previous to 1887. Except for a single year's absence, soda has had a continuous production since 1894. Potash and magnesium chloride have only recently been added to the commercial list, while the nitrates are still prospective. The possibilities for future developments of all these are very promising.

Our main resources of salines are the ancient lake beds of the desert regions of Imperial, Inyo, Kern, Los Angeles, and San Bernardino counties, and the waters of the Pacific Ocean.

The following tabulation shows amount and value of the saline minerals produced in California during the years 1915 and 1916, with increase in value for 1916 as compared with the previous year:

Substance	1915		1916		Increase (value)
	Tons	Value	Tons	Value	
Borax	67,004	$1,663,521	103,523	$2,409,375	$745,854
Magnesium chloride			851	6,407	6,407
Potash	1,076	19,391	17,908	663,605	644,214
Salt	169,028	368,737	186,148	455,695	86,958
Soda	5,799	83,485	10,593	264,825	181.340
Totals		$2,135,134		$3,799,907	$1,664,773

BORAX.

Bibliography: State Mineralogist Reports III, X, XII, XIII. Bulletins 24, 67.

Borax was first discovered in California in the waters of Tuscan Springs in Tehama County, January 8, 1856. Borax Lake, in Lake County, was discovered in September of the same year by Dr. John A. Veatch. This deposit was worked in 1864–1868, inclusive, and during that time produced 1,181,365 pounds of refined borax. This was the first commercial output of this salt in the United States; and California is still today the only American producer of borax.

Production from the dry lake or "playa" deposits of Inyo and San Bernardino counties began in 1873; but it was not until 1887 that the borax industry was revolutionized by the discovery of the colemanite beds at Calico in San Bernardino County. These have since been

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worked out, and the present output comes from similar beds in Inyo and Los Angeles counties. The colemanite deposits of Ventura County are at present unworked, owing to lack of transportation facilities.

During 1916 two producers reported a total output of 103,523 tons, valued at $2,409,375, compared with 67,004 tons, valued at $1,663,521, in 1915.

Value of the state's borax output since 1887 is shown in the following table:

Year	Value	Year	Value
1887	$116,689	1903	$661,400
1888	196,636	1904	698,810
1889	145,473	1905	1,019,158
1890	480,152	1906	1,182,410
1891	640,000	1907	1,200,913
1892	838,787	1908	1,117,000
1893	593,292	1909	1,163,960
1894	807,807	1910	1,177,960
1895	595,900	1911	1,456,672
1896	675,400	1912	1,122,713
1897	1,060,000	1913	1,491,530
1898	1,153,000	1914	1,483,500
1899	1,139,882	1915	1,663,521
1900	1,013,251	1916	2,409,375
1901	982,380		
1902	2,234,994	Total	$30,542,565

MAGNESIUM CHLORIDE.

Magnesium chloride is an important item in certain chemical uses, and in the preparation of Sorél cement in laying magnesite floors. In the past, Germany has been the principal source of this chloride, which source is at the present time, of course, cut off. For this reason experiments are being made to prepare it by acid solution from magnesite, which is so abundant in California. Some of the salt companies began its commercial preparation in 1916, from the residual bitterns obtained during the evaporation of sea water for its sodium chloride. This initial year's yield amounted to 851 tons, valued at $6,407.

Bitterns made at plants on San Francisco Bay carry 23 to 86 parts of magnesium per thousand, or 2.3% to 8.6% magnesium.[18]

Metallic magnesium is prepared electrolytically, utilizing generally an electrolyte of magnesium chloride and an alkaline chloride. Its commonest known use is in the powdered form for flashlights in photography. Its largest recent use is in the making of war munitions.[19]

[18] U. S. Dept. Agr. Bur. Soils, Bull. 94, p. 66, 1913.
[19] U. S. G. S., Min. Res. 1915, Pt. I, p. 740.

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It does not enter as an integral part into the explosives nor arms, but small quantities are put in shrapnel shells, that observers and gunners may know exactly where the shells are bursting. By day the burning magnesium gives a dense pure white cloud of magnesium oxide, and at night a dazzling white light. Larger quantities are used in aerial bombs and rockets for lighting up the country at night. Magnesium has as yet found but a limited direct use as a metal. Magnalium, an alloy of aluminum containing about 2% of magnesium and small percentages of other metals, is stated to be used in automobiles and aeroplanes. The possibilities for further important developments in this direction are promising.

NITRATES.

Bibliography: Bulletin 24.

Nitrates of sodium, potassium and calcium have been found in various places in the desert regions of the state, but no deposit of commercial value has been developed as yet. Interest in this class of mineral substance is increasing and closer search may be rewarded by workable discoveries. At present the principal commercial source of nitrates is the Chilean saltpeter deposits in South America.

The subject of the fixation of atmospheric nitrogen electrically is just now occupying a place in the public mind by reason of its success in Germany and Scandinavia. The possibilities of cheap hydroelectric power in California make the subject one of intense interest to us, as we have also the natural raw materials and chemicals to go with the power. Sodium and potassium cyanides can be made by fixation of atmospheric nitrogen electrically.

POTASH.

Bibliography: Bulletin 24. U. S. G. S., Min. Res. 1913, 1914, 1915. Senate Doc. No. 190, 62d Congress, 2d Session. Mining & Sci. Press, Vol. 112, p. 155; Vol. 114, p. 789.

Potash had not, previous to 1914, been produced commercially in California. Considerable money has been spent in the preliminary work incident to developing deposits of potash-bearing residues and brines in the old lake beds of the desert regions. The imports of potash salts and fertilizers from Germany previous to the European war had an annual value of several millions of dollars, and their cessation has made a domestic production imperative.

The normal pre-war price of $35 to $40 per ton for high-grade agricultural salts has been succeeded by figures of several times those amounts; until in April, 1916, the chloride was nominally quoted at $425 per ton and the sulphate from $350 to $400 per ton.

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During 1916 a total of 17,908 tons of potash-bearing material was produced in California, valued at $663,605. This is, in part, refined potassium chloride and sulphate, kelp ash and dried kelp, varying in potash content from 60% K_2O for the refined salts down to 14% in the dried kelp; in part, refined sulphate and treater dust from one of the cement mills; and, in part, concentrated salts from the brine of Searles Lake. The yield from Los Angeles and San Diego counties is from the operations of four kelp plants in each.

The bulk of this output was utilized in fertilizer preparations; but the product of one of the kelp plants was refined to the form of the nitrate for explosives manufacture. In addition to the amounts here given, some tonnage of potash salts was recovered from the residual bitterns by one of the soda-ash plants at Owens Lake, Inyo County, but not yet sold.

The large plant of the American Trona Corporation at Trona, on Searles Lake, San Bernardino County, began commercial operation in September, 1916, and is shipping crude salts carrying approximately 36% K_2O to Eastern fertilizer works, until their refinery at San Pedro is completed. These crude salts are stated to be made up of approximately 60% chloride and 30% borate, with small amounts of other constituents. For the current year, it is expected to increase the capacity from 50 tons to 100 tons daily. When their refinery is in operation they will separate the potash, soda, and borax before placing them on the market.

In the cement mill of the Riverside Portland Cement Company, the fine dust from ball and tube mills is collected by a Cottrell, electrical, fume precipitator, the material showing an approximately 11% potash content. Some sulphate is being prepared from this, but the bulk of the tonnage sold goes to fertilizer manufacturers. For the current year, 1917, the potash content is being enriched by the utilization of orthoclase feldspar in the cement mix. Not only in this manner has the extraction of potash from feldspar reached the commercial stage, but, at Baltimore, Maryland, the Star Chemical Company is using the "Thompson method,[20] in which the feldspar is roasted with salt cake and common salt, and then extracted, yielding over 80% of the original potash content of the rock." The Cushman-Coggeshall process employs as reagents, quicklime (CaO) and the $CaCl_2$ waste from the ammonia-soda alkali process. This "yields a sludge which is dried and ground, and contains above 70% of KCl, equal in quality to the imported German muriates."

The following tabulation shows the distribution of the 1916 output of potash in California:

[20] Min. & Sci. Press, Vol. 114, p. 789, June 9, 1917.

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County	Tons	Value
Los Angeles	1,864	$324,769
Riverside and San Bernardino*	13,894	163,032
San Diego	2,150	175,804
Totals	17,908	$663,605

*Combined to conceal output of a single operator in each.

The annual amounts and values of these potash materials, since their beginning in California, are shown by the following table:

Year	Tons	Value
1914	10	$460
1915	1,076	19,391
1916	17,908	663,605
Totals	18,994	$683,456

SALT.

Bibliography: State Mineralogist Reports II, XII, XIII, XIV. Bulletin 24.

Most of the salt produced in California is obtained by evaporating the waters of the Pacific Ocean, plants being located on the shores of San Francisco Bay, at Long Beach, and on San Diego Bay. Additional amounts are derived from lakes and lake beds in the desert regions of the state. The salt production of San Bernardino County is derived from deposits of rock salt which are worked by means of quarrying and steam shovels. A small amount of valuable medicinal salts is annually obtained in Mono and Tehama counties, by evaporation from mineral springs.

Formerly a considerable proportion of the table salt consumed in California was shipped in from Eastern points; but, at present California salt refineries supply not only our own markets but export a fair tonnage to other states and to Australia.

The 1916 output amounted to 186,148 tons, valued at $455,695, distributed as follows, by counties:

County	Tons	Value
Alameda	111,206	$263,773
San Bernardino	2,355	13,830
San Mateo	28,540	70,807
Inyo, Kern, Los Angeles, Modoc, Mono, Monterey, San Diego, Solano*	44,047	107,285
Totals	186,148	$455,695

*Combined to conceal output of a single operator in each.

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The above returns show an increase in both tonnage and value, although one plant in Alameda County lost about half of its crop by an early rain storm in September, and the plant of the Western Salt Company at San Diego was largely washed out by the breaking of the Lower Otay dam in January. There were 12 plants operating in Alameda, three each in San Bernardino and San Mateo, and one in each of the other counties tabulated, a total of 540 men being employed.

Amount and value of annual production of salt in California from 1887 to date is shown in the following tabulation:

Year	Tons	Value	Year	Tons	Value
1887	28,000	$112,000	1903	102,895	$211,365
1888	30,800	92,400	1904	95,968	187,300
1889	21,000	63,000	1905	77,118	141,925
1890	8,729	57,085	1906	101,650	213,228
1891	20,094	90,303	1907	88,063	310,967
1892	23,570	104,788	1908	121,764	281,469
1893	50,500	213,000	1909	155,680	414,708
1894	49,131	140,087	1910	174,920	395,417
1895	53,031	150,576	1911	173,332	324,255
1896	64,743	153,244	1912	185,721	383,370
1897	67,851	157,520	1913	204,407	462,681
1898	93,421	170,855	1914	223,806	583,553
1899	82,654	149,588	1915	169,028	368,737
1900	89,338	204,754	1916	186,148	455,695
1901	126,218	366,376			
1902	115,208	205,876	Totals	2,964,788	$7,166,122

SODA.

Bibliography: State Mineralogist Reports XII, XIII. Bulletins 24, 67.

During 1916, bicarbonate of soda and soda ash were produced by two plants in Inyo County, amounting to 10,593 tons, valued at $264,825, as compared with 5,799 tons, valued at $83,485 in 1915. Preparations are reported being made to ship natural sodium sulphate from the Carrizo Plains in eastern San Luis Obispo County.

These materials are used mainly in glass making, and the preparation of caustic soda. At one flotation mill in Utah handling copper ores they have found that the addition of soda ash gives a better froth and improves their extraction. A third plant now under construction near Keeler for manufacture of soda ash from the waters of Owens Lake, is expected to be in operation by August, 1917. The older plants are also stated to be enlarging. Information recently given to the State Mining Bureau would indicate that there is a market for a materially greater tonnage of soda ash than is at present obtainable on the Pacific coast.

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The total output, showing amount and value of these materials in California since the inception of the statistical records of the State Mining Bureau, is given in the table which follows:

Year	Tons	Value	Year	Tons	Value
1894	1,530	$20,000	1907		
1895	1,900	47,500	1908	9,600	$14,400
1896	8,000	65,000	1909	7,712	11,593
1897	5,000	110,000	1910	8,125	11,862
1898	7,000	154,000	1911	9,023	52,887
1899	10,000	250,000	1912	7,200	37,094
1900	1,000	50,000	1913	1,861	24,936
1901	8,000	400,000	1914	6,522	115,396
1902	7,000	50,000	1915	5,799	83,485
1903	18,000	27,000	1916	10,593	264,825
1904	12,000	18,000			
1905	15,000	22,500	Totals	167,865	$1,848,478
1906	12,000	18,000			

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CHAPTER SEVEN.

MINERAL PRODUCTION OF CALIFORNIA BY COUNTIES.

Introductory.

The state of California includes an area of 155,652 square miles and is divided into fifty-eight counties. Some mineral of commercial value exists in every county, and during 1916 active production was reported to the State Mining Bureau from fifty-seven counties of the fifty-eight. In the mountainous portions of the state are found the vein-forming minerals, largely. In the vast desert regions of southeastern California ancient lake beds afford an unlimited supply of saline deposits. Underlying the interior valleys of the central and southern portion of the state are the largest pools of crude oil in the world. Building stones and mineral earths of all descriptions are widely distributed throughout the length and breadth of the state.

Of the first ten counties in point of total output five (Kern, Orange, Fresno, Santa Barbara, Los Angeles) owe their position mainly to petroleum. Kern, due to its oil, leads all the others by nearly three times the total of Shasta, its nearest competitor. Shasta owes its rank to copper, gold, and zinc; San Bernardino, its place on account of tungsten, cement, copper, gold; Inyo, mainly to borax, zinc and lead; and the next five counties, Amador, Nevada, Yuba, Calaveras, Sacramento, mainly to gold. Twenty-five counties have each a total in excess of a million dollars, for 1916.

The counties with their mineral resources, production for 1916, etc., will be considered in detail in this chapter.

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Value of California Mineral Production, by Counties, for 1916, Arranged in the Order of Their Importance.

	County	Value		County	Value
1.	Kern	$37,826,907	31.	Mariposa	$487,971
2.	Shasta	13,639,508	32.	Sonoma	472,048
3.	Orange	8,905,086	33.	El Dorado	470,687
4.	Fresno	8,061,193	34.	San Joaquin	468,862
5.	San Bernardino	6,569,147	35.	San Diego	397,168
6.	Inyo	4,600,096	36.	Humboldt	274,895
7.	Santa Barbara	4,535,029	37.	Stanislaus	253,022
8.	Los Angeles	4,463,045	38.	San Luis Obispo	245,807
9.	Amador	3,811,428	39.	Mono	240,990
10.	Nevada	3,744,143	40.	Madera	222,758
11.	Yuba	3,237,828	41.	Lake	180,996
12.	Calaveras	2,965,592	42.	Marin	178,306
13.	Sacramento	2,178,674	43.	San Mateo	135,408
14.	Santa Cruz	1,679,111	44.	Monterey	109,872
15.	Plumas	1,399,335	45.	Imperial	105,333
16.	Butte	1,356,925	46.	Merced	81,530
17.	Contra Costa	1,279,060	47.	Glenn	81,162
18.	Riverside	1,234,252	48.	San Francisco	76,437
19.	San Benito	1,213,447	49.	Mendocino	55,680
20.	Solano	1,205,335	50.	Tehama	54,353
21.	Ventura	1,135,430	51.	Colusa	42,803
22.	Alameda	1,094,167	52.	Kings	26,788
23.	Napa	1,078,537	53.	Lassen	9,725
24.	Placer	1,042,629	54.	Sutter	6,450
25.	Tuolumne	1,004,262	55.	Modoc	3,559
26.	Tulare	947,200	56.	Del Norte	2,432
27.	Santa Clara	851,948	57.	Yolo	300
28.	Trinity	846,561	58.	Alpine	----------
29.	Sierra	729,497			
30.	Siskiyou	580,896		Total	$127,901,610

ALAMEDA.

Area: 843 square miles.

Population: 359,000 (estimate by Chamber of Commerce, 1914).

Alameda County, while in no sense one of the "mining counties," comes twenty-second on the list with a value of mineral products for 1916 of $1,094,167, an increase from the 1915 total, which was $861,683. The mineral resources of this county include asbestos, brick, chromite, clay, coal, limestone, magnesite, manganese, pyrite, salt, soapstone, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	612 tons	$7,344
Brick	23,551 M.	315,941
Clay	4,060 tons	2,750
Manganese	562 tons	9,005
Pyrite	16,394 tons	65,110
Salt	111,206 tons	263,773
Stone, miscellaneous	----------	403,587
Other minerals*	----------	26,657
Total	----------	$1,094,167

*Includes limestone, magnesium chloride and magnesite.

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ALPINE.

Area: 776 square miles.

Population: 309 (1910 census).

Alpine has in the past shown a small production of gold and silver, but dropped out of the list of producing counties in 1914.

This county lies just south of Lake Tahoe, in the high Sierra Nevada range of mountains. Its area is 776 square miles, containing a population of but 309 persons. Transportation is by wagon or mule back, and facilities in general are lacking to promote development work of any kind.

The mineral resources of this section are varied and the country has not yet been thoroughly prospected. Barium, copper, gold, gypsum, lead, limestone, pyrite, rose quartz, silver, tourmaline, and zinc have been found here to some extent.

AMADOR.

Area: 601 square miles.

Population: 11,000 (estimate by County Clerk, 1914).

The value of Amador County's mineral production decreased from $4,063,762 in 1915 to $3,811,428, thus taking ninth place on the list of counties in the state as regards total value of mineral substances marketed. The feature of the decrease was the drop in gold yield, due mainly to a six-weeks' strike on the Mother Lode.

Although having an output consisting of 10 different minerals, the leading product, gold, makes up over 96% of the entire total. Amador led the state in gold production in 1915, but was slightly exceeded in 1916 by Nevada County.

The mineral resources of this county, in the main, include asbestos, brick, chromite, clay, coal, copper, gold, lime, quartz crystals, glass-sand, sandstone, silver, soapstone, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	300 tons	$3,700
Clay	29,246 tons	31,106
Copper	12,349 lbs.	3,038
Gold		3,660,550
Silica	4,341 tons	12,802
Silver		18,705
Soapstone and talc	495 tons	2,475
Stone, miscellaneous		1,300
Other minerals*		77,752
Total		$3,811,428

*Includes brick, coal, lime, manganese and sandstone.

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BUTTE.

Area: 1,722 square miles.

Population: 31,000 (estimate by Chamber of Commerce, 1914).

Location: North central portion of state.

Butte, sixteenth county in California in regard to the value of its mineral output, reported a commercial production of eight mineral substances, having a total value of $1,356,925, as compared with $1,622,245 for 1915. As will be noted in the following tabulation, gold is by far the most important item. Butte stands sixth among the gold-producing counties of the state. Among the mineral resources of this section are asbestos, barytes, chromite, gems, gold, limestone, marble, mineral water, platinum minerals, silver, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	1,451 tons	$13,940
Gems		357
Gold		1,257,231
Mineral water	3,150 gals.	1,125
Platinum	76 ounces	3,472
Silver		3,332
Stone, miscellaneous		67,892
Other minerals		9,576
Total		$1,356,925

CALAVERAS.

Area: 1,027 square miles.

Population: 9,171 (1910 census.)

Location: East central portion of state—Mother Lode district.

Calaveras County reported production of 9 different minerals, valued at $2,965,592, during the year 1916, as compared with the 1915 output worth $2,161,893. Gold, copper and silver are the chief mineral substances produced. In regard to total value of mineral output Calaveras stands twelfth among the counties of the state; it is fifth in gold, second in copper, and third in silver.

The principal mineral resources developed and undeveloped are: Asbestos, barytes, chromite, clay, copper, fuller's earth, gold, graphite, limestone, magnesite, marble, mineral paint, mineral water, platinum minerals, pyrite, quartz crystals, silver, soapstone, and miscellaneous stone.

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Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	1,636 tons	$12,570
Copper	6,099,509 lbs.	1,500,479
Gold		1,356,120
Lead	7,238 lbs.	499
Mineral water	18,255 gals.	7,025
Platinum	54 ounces	2,453
Silver		83,643
Stone, miscellaneous		2,503
Other minerals		300
Total		$2,965,592

COLUSA.

Area: 1,140 square miles.

Population: 7,882 (estimate by Chamber of Commerce, 1914).

Location: Sacramento Valley.

Colusa County lies largely in the basin of the Sacramento Valley. Its western border, however, rises into the foothills of the Coast Range of mountains, and its mineral resources—to a great extent undeveloped—include coal, chromite, copper, gypsum, manganese, mineral water, pyrite, quicksilver, sandstone, miscellaneous stone, sulphur, and in some places traces of gold and silver.

The value of the 1916 production was $42,803, an increase from the 1915 figures of $16,003, giving it fifty-first place.

Substance	Amount	Value
Quicksilver	285 flasks	$26,648
Stone, miscellaneous		550
Other minerals*		15,605
Total		$42,803

*Includes mineral paint, mineral water and sandstone.

CONTRA COSTA.

Area: 714 square miles.

Population: 52,500 (estimate by Chamber of Commerce, 1914).

Contra Costa, like Alameda County, lies off the eastern shores of San Francisco Bay, and is not commonly considered among the mineral-producing counties of the state. It stands seventeenth on the list in

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this respect, however, with an output valued at $1,279,060 for the calendar year 1916. Various structural materials make up the chief items, including brick, cement, limestone, and miscellaneous stone. Among the others are asbestos, clay, coal, gypsum, manganese, mineral water and soapstone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Brick	16,672 M.	$148,730
Mineral water	351,724 gals.	6,154
Stone, miscellaneous		363,753
Other minerals*		760,423
Total		$1,279,060

*Includes cement, clay, coal and limestone.

DEL NORTE.

Area: 1,024 square miles.

Population: 2,417 (1910 census).

Location: Extreme northwest corner of state.

Transportation: Wagon and mule back; steamer from Crescent City.

Del Norte rivals Alpine County in regard to inaccessibility. Like the latter county also, given transportation and kindred facilities, this portion of the state presents a wide field for development along mining lines especially. Its chief mineral resources, largely untouched, are chromite, copper, gems, gold, graphite, iron, platinum minerals, silver, and miscellaneous stone.

Commercial production for 1916, giving it fifty-sixth place, was as follows:

Substance	Amount	Value
Gold		$405
Platinum	2 ounces	73
Silver		2
Stone, miscellaneous		1,685
Other minerals*		267
Total		$2,432

*Includes chromite and copper.

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EL DORADO.

Area: 1,753 square miles.

Population: 8,000 (estimate by County Clerk, 1914).

Location: East central portion of the state; northernmost of the Mother Lode counties.

El Dorado County, which contains the locality where gold in California was first heralded to the world, comes thirty-third on the list of counties ranked according to the value of their total mineral production during the year 1916. In addition to the segregated figures here given, a large tonnage of limestone is annually shipped from El Dorado for use in cement manufacture, and whose value is included in the state total for cement.

The mineral resources of this section, many of them undeveloped, include asbestos, barytes, chromite, clay, copper, gems, gold, iron, molybdenum, limestone, quartz crystals, quicksilver, glass-sand, slate, soapstone, silver and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	5,260 tons	$72,560
Gold		361,821
Lime and limestone		19,613
Silica	886 tons	1,717
Silver		1,496
Stone, miscellaneous		12,000
Other minerals*		1,480
Total		$470,687

*Includes copper and soapstone.

FRESNO.

Area: 5,950 square miles.

Population: 120,000 (estimate of Board of Supervisors, 1914).

Location: South central portion of state.

Fresno County, fourth in importance as a mineral producer among the counties of California, reported an output for 1916 of thirteen mineral substances, with a total value of $8,061,193, an increase over the reported 1915 production, which was worth $8,152,300. The great bulk of the above value is derived from the petroleum production of the Coalinga field.

The mineral resources of this county are many, and, aside from crude oil, are far from being fully developed. They include asbestos, barytes, brick, chromite, copper, gems, gold, graphite, gypsum, iron,

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magnesite, natural gas, petroleum, quicksilver, silver, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	9,060 tons	$151,824
Copper	29,173 lbs.	7,177
Gold		693
Granite	11,000 cu. ft.	25,000
Lead	668 lbs.	46
Magnesite	5,829 tons	49,082
Natural gas	2,346,917 M. cu. ft.	163,941
Petroleum	14,594,246 bbls.	7,530,631
Silver		69
Stone, miscellaneous		95,830
Other minerals*		36,900
Total		$8,061,193

*Includes brick, fuller's earth and mineral water.

GLENN.

Area: 1,259 square miles.

Population: 7,172 (1910 census).

Glenn County, standing forty-seventh, owes its position among the mineral-producing counties of the state mainly to the presence of large deposits of sand and gravel which are annually worked, the product being used for railroad ballast, etc. In the foothills in the western portion of the county, deposits of chromite, copper, manganese, sandstone, and soapstone have been found.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$41,180
Other minerals		39,982
Total		$81,162

HUMBOLDT.

Area: 3,634 square miles.

Population: 37,500 (estimate by Chamber of Commerce, 1914).

Location: Northwestern portion of state, bordering on Pacific Ocean.

Humboldt County is almost entirely mountainous, transportation within its limits being very largely by wagon road and trail, and until recent years was reached from the outside world by steamer only.

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The county is rich in mineral resources, among which are brick, chromite, coal, clay, copper, gold, iron, mineral water, natural gas, petroleum, platinum, silver, and miscellaneous stone.

Nine mineral substances, as shown by the table given below, having a total value of $274,895, were produced in 1916, as compared with the 1915 output, worth $358,686, the principal item being due to the large amount of stone being used on the Eureka Harbor breakwater. Humboldt ranks thirty-sixth among the counties of the state for the year.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Gold		$21,279
Mineral water	3,000 gals.	750
Platinum	7 ounces	296
Silver		55
Stone, miscellaneous		60,260
Other minerals*		192,255
Total		$274,895

*Includes brick, clay, granite and natural gas.

IMPERIAL.

Area: 4,089 square miles.

Population: 50,000 (estimate by Chamber of Commerce, 1914).

Location: Extreme southeast corner of the state.

During 1916 Imperial County produced eight mineral substances having a total value of $105,333, as compared with the 1915 output, worth $77,433. Its rank is forty-fifth. This county contains large undeveloped deposits of gold, gypsum, lead, marble, pumice, salt, and silver.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Gold		$23,338
Silver		155
Stone, miscellaneous		34,834
Other minerals*		47,006
Total		$105,333

*Includes brick, copper, lead, pumice and strontium.

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INYO.

Area: 10,019 square miles.

Population: 7,500 (estimate by Chamber of Commerce, 1914).

Location: Lies on eastern border of state, north of San Bernardino County.

Inyo, the second largest county in the state, and containing less than one inhabitant per square mile, is extremely interesting from a mineralogical point of view. It is noted because of the fact that within its borders are located both the highest point, Mount Whitney (elevation 14,502 feet), and the lowest point, Death Valley (elevation 290 feet below sea level), in the United States. In the higher mountainous sections are found many vein-forming minerals, and in the lake beds of Death Valley saline deposits exist.

Inyo's mineral production during the year 1916 reached a value of $4,600,090, the county standing sixth among the counties of the state in this respect, its advance from 1915 being due to increases in value of borax, lead, silver, tungsten and zinc. Its mineral resources include antimony, asbestos, barytes, bismuth, borax, copper, gems, gold, gypsum, lead, magnesite, marble, molybdenum, mineral water, nitre, platinum, pumice, quicksilver, salt, silver, soda, sulphur, talc, tungsten, and zinc.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Copper	274,032 lbs.	$67,412
Dolomite	3,596 tons	14,700
Gold		131,722
Lead	11,185,321 lbs.	771,787
Silver		232,441
Soda	10,593 tons	264,825
Stone, miscellaneous		23,040
Talc	658 tons	4,606
Zinc	5,758,703 lbs.	771,666
Other minerals*		2,317,897
Total		$4,600,096

*Includes antimony, borax, gypsum, marble, molybdenum, salt and tungsten.

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KERN.

Area: 8,003 square miles.

Population: 50,000 (estimate by Board of Supervisors).

Location: South central portion of state.

Kern County, because of its immense, productive oil fields, stands pre-eminent among all counties of California in the value of its mineral output, the exact figures for 1916 being $37,826,907. This is larger by more than twenty-four million dollars than the succeeding county on the list. This figure also exceeds the value of the total gold output of the entire state by approximately $16,500,000. The 1915 mineral output for the county was worth $25,335,184.

Among the mineral resources, developed and undeveloped, of this section are: Antimony, asbestos, asphalt, barytes, borax, brick, clay, copper, fuller's earth, gems, gold, gypsum, iron, lead, limestone, magnesite, marble, mineral paint, natural gas, petroleum, potash, salt, silver, soapstone, soda, sulphur, and tungsten.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Antimony	145 tons	$5,880
Brick	3,177 M.	23,824
Copper	24,754 lbs.	6,089
Gold	----------	747,042
Lead	24,274 lbs.	1,675
Lime and limestone	----------	30,047
Natural gas	16,679,658 M. cu. ft.	1,379,033
Petroleum	54,120,509 bbls.	34,691,246
Silica	4,100 tons	23,700
Silver	----------	8,745
Stone, miscellaneous	----------	63,723
Tungsten concentrates	193 tons	482,387
Other minerals*	----------	363,516
Total	----------	$37,826,907

*Includes cement, clay, feldspar, fuller's earth, magnesite, quicksilver and salt.

KINGS.

Area: 1,159 square miles.

Population: 23,500 (estimate by Chamber of Commerce, 1914).

Location: South central portion of state.

Little development has taken place in Kings County along mineral lines to date. Deposits of fuller's earth, gypsum, mineral paint, natural gas, and quicksilver, of undetermined extent, have been found in the county. Some drilling for oil is under way.

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In fifty-second place, commercial production for 1916 was as follows:

Substance	Amount	Value
Natural gas	258 M. cu. ft.	$608
Other minerals		26,180
Total		$26,788

LAKE.

Area: 1,278 square miles.

Population: 5,600 (estimate by Chamber of Commerce, 1914).

Location: About fifty miles north of San Francisco Bay and the same distance inland from the Pacific Ocean.

On account of its topography and natural beauties, Lake County is sometimes referred to as the Switzerland of America. The mineral resources which exist here are many and varied, actual production being comparatively small, as shown by the table below. Some of the leading minerals found in this section, in part as yet undeveloped, are borax, chromite, clay, copper, gems, gold, gypsum, mineral water, quicksilver, silver, and sulphur.

In forty-first place, commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	871 tons	$15,070
Mineral water	195,650 gals.	54,160
Quicksilver	1,139 flasks	106,496
Stone, miscellaneous		4,500
Other minerals		770
Total		$180,996

LASSEN.

Area: 4,531 square miles.

Population: 7,000 (estimate by County Clerk, 1914).

Location: Northeast portion of state.

Lassen County is one of the little explored sections of California. Since about 1912 a railroad traversing the county north and south has been in operation, thus affording opportunity for development along mineral and other lines.

Among the mineral resources of this county are copper, gems, gypsum, gold, silver, and sulphur.

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In fifty-third place, commercial production for 1916 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$9,725

LOS ANGELES.

Area: 4,067 square miles.

Population: 800,000 (estimate by Chamber of Commerce, 1913).

Mineral production in Los Angeles County for the year 1916 amounted in value to $4,463,045, as compared with the 1915 output, worth $4,168,612. This county ranks eighth in the state as a mineral producer, this year.

Its output of brick was over a half-million dollars, and that of petroleum amounted nearly to two million dollars. Among its mineral resources may be noted asphalt, barytes, borax, brick, clay, fuller's earth, gems, gold, graphite, gypsum, infusorial earth, limestone, marble, mineral paint, mineral water, natural gas, petroleum, salt, glass-sand, sandstone, serpentine, silver, soapstone, and miscellaneous stone. Some potash is obtained from kelp.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Brick	82,005 M.	$760,912
Clay	6,233 tons	10,549
Gems		600
Mineral water	320,700 gals.	8,552
Natural gas	2,083,664 M. cu. ft.	139,522
Petroleum	2,875,468 bbls.	1,871,930
Potash	1,864 tons	324,769
Silica	612 tons	1,684
Stone, miscellaneous		971,153
Other minerals*		373,374
Total		$4,463,045

*Includes borax, copper, graphite and salt.

MADERA.

Area: 2,112 square miles.

Population: 12,000 (estimate by Chamber of Commerce, 1914).

Location: East central portion of state.

Madera County produced five mineral substances during the year 1916, having a total value of $222,758, as compared with the 1915 output, worth $145,063. This county contains deposits of copper, gold, iron, lead, molybdenum, pumice, silver, and building stone.

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In fortieth place, commercial production for 1916 was as follows:

Substance	Amount	Value
Copper	124,286 lbs.	$30,574
Gold		10,306
Granite	128,865 cu. ft.	172,191
Silver		1,772
Stone, miscellaneous		7,915
Total		$222,758

MARIN.

Area: 529 square miles.

Population: 28,400 (estimate by Chamber of Commerce, 1914).

Location: Adjoins San Francisco on the north.

Mineral production in Marin County during the year 1916 reached a value of $178,306, as compared to the 1915 output, worth $160,528. This county is not especially prolific in minerals, although among its resources along these lines are brick, gems, manganese, mineral water, soapstone, and miscellaneous stone.

In forty-second place, commercial production for 1916 was:

Substance	Amount	Value
Stone, miscellaneous		$104,306
Other minerals*		74,000
Total		$178,306

*Includes brick and mineral water.

MARIPOSA.

Area: 1,463 square miles.

Population: 3,956 (1910 census).

Location: Most southerly of the Mother Lode counties. East central portion of state.

Mariposa County is one of the distinctly "mining" counties of the state, although it stands but thirty-first on the list of counties in regard to the value of its mineral output for 1916, with a total of $487,971, as compared with the 1915 figures of $412,326. The increase is due to gold.

Its mineral resources are varied; among the more important items being barytes, copper, gems, gold, lead, marble, silver, slate, soapstone, and miscellaneous stone.

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Commercial production for 1916 was as follows:

Substance	Amount	Value
Copper	162,318 lbs.	$39,930
Gold		401,718
Lead	1,857 lbs.	128
Silver		2,680
Stone, miscellaneous		39,372
Other minerals		4,143
Total		$487,971

MENDOCINO.

Area: 3,453 square miles.

Population: 27,000 (estimate by Chamber of Commerce, 1914).

Location: Joins Humboldt County on the south and bounded by the Pacific Ocean on the west.

Mendocino's annual mineral production is small, the 1916 output being valued at $55,680, ranking it forty-ninth among the counties. That of 1915 was worth $24,536. The increase is due to manganese.

Deposits of undetermined value, of asbestos, chromite, coal, copper, graphite, magnesite, and mineral water have been found, as well as traces of gold and silver. For the coming year there are good prospects for a continued commercial yield of manganese ore.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Magnesite	300 tons	$2,400
Manganese	1,735 tons	43,005
Stone, miscellaneous		8,275
Other minerals		2,000
Total		$55,680

MERCED.

Area: 1,995 square miles.

Population: 20,000 (estimate by Chamber of Commerce, 1914).

Location: About the geographical center of the state.

Merced County as a whole lies in the San Joaquin Valley, and it figures as one of the lesser mineral-producing counties of the state. The 1916 mineral output was valued at $81,530. Gold, platinum and silver, obtained by dredging, are among the important items. Copper and crushed rock have also been commercially produced. Undeveloped

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deposits of antimony, magnesite, quicksilver, and limestone have been noted in this county, in addition to the foregoing.

In forty-sixth place, commercial production during 1916 was as follows:

Substance	Amount	Value
Magnesite	90 tons	$720
Other minerals*		80,810
Total		$81,530

*Includes gold, platinum and silver.

MODOC.

Area: 3,823 square miles.

Population: 6,191 (1910 census).

Location: The extreme northeast corner of the state.

Modoc County, like Lassen, has only recently had the benefit of communication with the outside world by rail. Among its known mineral resources are: Clay, coal, gold, iron, quicksilver, salt, and silver.

In fifty-fifth place, commercial production for 1916 was as follows:

Substance	Amount	Value
Gold		$2,729
Silver		90
Stone, miscellaneous		200
Other minerals		540
Total		$3,559

MONO.

Area: 3,030 square miles.

Population: 2,100 (estimate by County Clerk, 1914).

Location: Is bordered by the state of Nevada on the east and is about in the central portion of the state measured on a north and south line.

Gold mining has been carried on in portions of Mono County for many years, although taken as a whole it lies in a rather inaccessible country and has been but superficially explored. It is in the continuation of the highly mineralized belt which was noted in Inyo County and contains among other mineral resources barytes, bismuth, clay, copper, gold, gypsum, iron, lead, limestone, molybdenum, pumice, salt, silver, and travertine.

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In thirty-ninth place, commercial production for 1916 was as follows:

Substance	Amount	Value
Gold		$237,084
Silver		3,606
Other minerals		300
Total		$240,990

MONTEREY.

Area: 3,330 square miles.

Population: 25,250 (estimate by Chamber of Commerce, 1914).

Location: West central portion of state, bordering on Pacific Ocean.

Monterey County produced eight mineral substances during the year 1916, having a total value of $109,872, as compared with the 1915 output worth $84,986. Its mineral resources include brick, clay, copper, coal, feldspar, fuller's earth, gold, silver, gypsum, infusorial earth, limestone, mineral water, petroleum, quicksilver, glass-sand, sandstone, silver, and miscellaneous stone.

In forty-fourth place, commercial production for 1916 was as follows:

Substance	Amount	Value
Mineral water	5,900 gals.	$590
Stone, miscellaneous		58,623
Other minerals*		50,659
Total		$109,872

*Includes barytes, feldspar, infusorial earth, quicksilver, salt and silica.

NAPA.

Area: 783 square miles.

Population: 26,500 (estimate by Chamber of Commerce, 1914).

Location: Directly north of San Francisco Bay—one of the "bay counties."

Napa, because of its production of structural and industrial materials and quicksilver, stands twenty-third on the list of mineral-producing counties in California. Its mineral resources include asbestos, barytes, copper, cement, gypsum, magnesite, mineral water, quicksilver, sandstone, soapstone, and miscellaneous stone.

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Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	715 tons	$11,559
"Granite" (tuff)	119,500 cu. ft.	5,500
Magnesite	13,960 tons	108,556
Mineral water	152,764 gals.	93,370
Quicksilver	1,150 flasks	107,525
Stone, miscellaneous		88,441
Other minerals		663,586
Total		$1,078,537

NEVADA.

Area: 974 square miles.

Population: 15,500 (estimate by Chamber of Commerce, 1914).

Location: North of Lake Tahoe, on the eastern border of the state.

Nevada, one of the mountain counties of California, led all others in its gold output for 1915. Nevada County stands tenth on the list in regard to the value of its total mineral output, with a figure of $3,744,143, as compared with the 1915 production worth $3,492,946.

While this county actually produces little else in the mineral line aside from gold and silver, its resources cover a wide scope, including antimony, asbestos, barytes, bismuth, chromite, clay, copper, gems, iron, lead, mineral paint, pyrite, soapstone, and tungsten.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	981 tons	$12,795
Copper	3,487 lbs.	858
Gold		3,669,878
Granite	100 cu. ft.	100
Lead	1,036 lbs.	71
Silver		35,741
Stone, miscellaneous		1,225
Other minerals*		23,475
Total		$3,744,143

*Includes manganese, platinum and tungsten.

ORANGE.

Area: 795 square miles.

Population: 56,500 (estimate by Chamber of Commerce, 1914).

Location: Southwestern portion of state, bordering Pacific Ocean.

Orange County is one of the many in California which on casual inspection appears to be anything but a mineral-producing section. It

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stands, however, as the third county in the state in regard to the total value of mineral output, its highly productive oil fields making such a condition possible.

This county shows a gain in 1916, with a total value of mineral products of $8,905,086, from the 1915 output, worth $6,617,112.

Aside from the substances actually produced and noted in the table below, coal, gypsum, iron, infusorial earth, sandstone, and tourmaline have been found in Orange County.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Brick	1,186 M.	$8,300
Natural gas	2,278,922 M. cu. ft.	139,281
Petroleum	13,198,591 bbls.	8,750,666
Stone, miscellaneous		3,773
Other minerals		3,066
Total		$8,905,086

PLACER

Area: 1,395 square miles.

Population: 18,237 (1910 census).

Location: Eastern border of state directly west of Lake Tahoe.

While standing only twenty-fourth on the list of mineral-producing counties, Placer contains a wide variety of mineral substances which have never been commercially exploited. Its leading products are gold, granite, copper, and clay. Other mineral resources, some of them undeveloped, are: Asbestos, brick, chromite, coal, gems, iron, lead, limestone, magnesite, manganese, marble, quartz crystals, glass-sand, silver, soapstone, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	774 tons	$11,956
Brick	2,540 M.	79,000
Clay (pottery)	29,018 tons	36,230
Copper	1,437,441 lbs.	353,610
Gold		428,400
Granite		80,931
Silver		24,928
Stone, miscellaneous		17,026
Other minerals*		10,548
Total		$1,042,629

*Includes limestone, lead and magnesite.

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PLUMAS.

Area: 2,594 square miles.

Population: 5,259 (1910 census).

Location: Northeastern border of state, south of Lassen.

A considerable portion of the area of Plumas County lies in the high mountains, and deposits of the metals, especially gold and copper, are found there. Lack of transportation and other facilities have retarded its growth, but its future is decidedly promising. Mineral production for 1916 was valued at $1,399,335, as compared with the 1915 output, worth $745,515, the increase being largely due to copper.

Among its mineral resources are: Chromite, copper, gold, granite, iron, lead, limestone, manganese, platinum minerals, silver, tungsten, and zinc.

In fifteenth place, commercial production for 1916 was as follows:

Substance	Amount	Value
Copper	4,932,928 lbs.	$1,213,500
Gold		133,385
Silver		46,542
Stone, miscellaneous		1,988
Other minerals*		3,920
Total		$1,399,335

*Includes chromite, granite and molybdenum.

RIVERSIDE.

Area: 7,240 square miles.

Population: 45,000 (estimate by County Clerk, 1914).

Location: Southern portion of state.

Riverside is the fourth county in the state in size and the eighteenth in regard to the total value of mineral output for 1916. Within its borders are included mountain, desert, and agricultural land. Its mineral resources include metals, structural and industrial materials, and salines, some of the more important being asbestos, borax, brick, cement, clay, coal, copper, feldspar, gems, gold, graphite, gypsum, iron, lead, limestone, manganese, magnesite, marble, mineral paint, mineral water, nitre, salt, glass-sand, soapstone, silver, miscellaneous stone, and tin.

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Commercial production for 1916 was as follows:

Substance	Amount	Value
Brick	1,831 M.	$28,593
Clay (pottery)	56,228 tons	56,090
Copper	58,617 lbs.	14,420
Gold		7,855
Granite	8,660 cu. ft.	4,890
Gypsum	4,220 tons	8,340
Lead	350 lbs.	24
Silica	901 tons	1,642
Silver		338
Stone, miscellaneous		159,555
Other minerals*		952,505
Total		$1,234,252

*Includes cement, feldspar, magnesite, manganese, mineral water and potash.

SACRAMENTO.

Area: 983 square miles.

Population: 90,000 (estimate by Chamber of Commerce, 1913).

Location: North central portion of state.

Sacramento stands thirteenth among the counties of the state as a mineral producer, the output, principally gold, for 1916 being valued at $2,178,674, as compared with the 1915 production, worth $2,562,281. In regard to gold output alone this county ranks fourth, being exceeded only by Nevada, Amador, and Yuba counties. Its mineral resources include: Brick, clay, gold, natural gas, platinum, silver, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Brick	8,924 M.	$91,615
Gold		1,833,855
Lead	227 lbs.	16
Platinum	195 ounces	8,892
Silver		3,578
Stone, miscellaneous		194,718
Other minerals*		46,000
Total		$2,178,674

*Includes pottery clay and natural gas.

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SAN BENITO.

Area: 1,392 square miles.

Population: 8,750 (estimate by County Clerk, 1914).

Location: West central portion of state.

Although nineteenth among the counties of the state in regard to value of total mineral production, San Benito leads in one important branch of the mineral industry, namely, quicksilver.

Its other mineral resources, many of them undeveloped, include: Antimony, bituminous rock, chromite, coal, gypsum, gems, limestone, mineral water, soapstone, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Dolomite	8,100 tons	$25,515
Quicksilver	11,110 flasks	1,032,156
Stone, miscellaneous		155,250
Other minerals*		526
Total		$1,213,447

*Includes antimony and mineral water.

SAN BERNARDINO.

Area: 20,157 square miles.

Population: 53,000 (estimate by board of supervisors, 1914).

Location: Southeastern portion of state.

San Bernardino, by far the largest county in the state, ranks fifth as regards the value of its mineral output for 1916, with a total of $6,569,147, as compared with the 1915 total of $2,674,042. The marked increase is due mainly to tungsten and copper, the well-known Atolia district contributing the former.

This county, consisting largely of mountain and desert country, is highly mineralized, a few of the more important mineral resources being: Asbestos, barytes, borax, brick, cement, clay, copper, gems, gold, gypsum, iron, lead, limestone, manganese, marble, mineral paint, mineral water, nitre, potash, salt, glass-sand, silver, soapstone, soda, miscellaneous stone, strontium, talc, tungsten, tuff, vanadium, and zinc.

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Commercial production for 1916 was as follows:

Substance	Amount	Value
Cement	1,036,000 bbls.	$1,246,000
Copper	1,577,901 lbs.	388,164
Gems		1,000
Gold		279,813
Granite	7,500 cu. ft.	2,500
Lead	673,801 lbs.	46,492
Lime	151,670 bbls.	54,317
Limestone	65,174 tons	63,486
Mineral water	40,500 gals.	6,500
Salt	2,355 tons	13,830
Silver		67,146
Stone, miscellaneous		172,454
Tungsten concentrates	1,921 tons	3,915,434
Zinc	707,062 lbs.	94,746
Other minerals*		217,265
Total		$6,569,147

*Includes brick, dolomite, feldspar, gypsum, manganese, mineral paint, pumice, potash, talc and strontium.

SAN DIEGO.

Area: 4,221 square miles.

Population: 125,379 (estimate by County Clerk, 1914).

Location: Extreme southwest corner of state.

San Diego, first in California in the production of gem stones, ranks thirty-fifth in the total value of its mineral output. This figure for 1916 equaled $397,168, as compared to the 1914 output worth $211,129. Aside from minerals commercially produced, as shown below, San Diego County contains deposits of asbestos, bismuth, lithia, marble, nickel, soapstone, tin, and tungsten. Potash is produced from kelp.

A new development is the shipping of pebbles for grinding mills.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Brick	4,001 M.	$36,842
Clay (pottery)	283 tons	613
Copper	16,806 lbs.	4,134
Gems		2,710
Potash	2,150 tons	175,804
Stone, miscellaneous		163,925
Other minerals*		13,140
Total		$397,168

*Includes granite, lithia, mineral water and salt.

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SAN FRANCISCO.

Area: 43 square miles.

Population: 527,000 (estimate by Chamber of Commerce, 1915).

Surprising as it may appear at first glance, San Francisco County is listed among the mineral producing sections of the state, actual production consisting of crushed rock, sand, and gravel. Small quantities of various valuable mineral substances are found here, including cinnabar, gypsum, lignite, and magnesite, none, however, in paying quantities.

In forty-eighth place, commercial production for 1916 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$76,437

SAN JOAQUIN.

Area: 1,448 square miles.

Population: 70,000 (estimate by Chamber of Commerce, 1914).

Location: Central portion of state.

San Joaquin County reported a mineral production for the year 1916 having a total value of $468,862, as compared with the 1915 output, worth $248,394. Comparatively few mineral substances are found here, the chief ones being brick, clay, infusorial earth, manganese, natural gas, glass-sand, and miscellaneous stone.

In thirty-fourth place, commercial production for 1916 was as follows:

Substance	Amount	Value
Brick	10,189 M.	$158,722
Manganese	6,493 tons	115,460
Natural gas	182,441 M. cu. ft.	141,605
Stone, miscellaneous		53,075
Total		$468,862

SAN LUIS OBISPO.

Area: 3,334 square miles.

Population: 25,000 (estimate by Chamber of Commerce, 1914).

Location: Bordered by Kern County on the east and the Pacific Ocean on the west.

The total value of the mineral production of San Luis Obispo County in 1916 was $245,807, as compared with the 1915 output, worth

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$227,632. Among its mineral resources, both developed and undeveloped, are: Asphalt, bituminous rock, brick, chromite, coal, copper, gold, gypsum, infusorial earth, limestone, marble, mineral water, onyx, petroleum, quicksilver, silver and miscellaneous stone.

In thirty-eighth place, commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	1,855 tons	$27,733
Brick	4,150 M.	45,500
Copper	356 lbs.	88
Mineral water	2,500 gals.	475
Petroleum	11,670 bbls.	5,252
Quicksilver	1,227 flasks	114,724
Stone, miscellaneous		49,318
Other minerals*		2,717
Total		$245,807

*Includes bituminous rock, clay (pottery) and sandstone.

SAN MATEO.

Area: 447 square miles.

Population: 35,000 (estimate by Chamber of Commerce, 1914).

Location: Peninsula, adjoined by San Francisco on the north.

San Mateo's most important mineral products are stone, brick, and salt, the last-named being derived by evaporation from the waters of San Francisco Bay. The total value of all mineral production during 1916 equaled $135,408, as compared with the 1915 figures of $177,891.

Small amounts of barytes, chromite, infusorial earth and quicksilver have been discovered in addition to the items of economic value noted below.

In forty-third place, commercial production for 1916 was as follows:

Substance	Amount	Value
Brick	986 M.	$38,121
Clay (pottery)	593 tons	732
Gems		85
Salt	28,540 tons	70,807
Stone, miscellaneous		25,663
Total		$135,408

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SANTA BARBARA.

Area: 2,740 square miles.

Population: 32,750 (estimate by Chamber of Commerce, 1914).

Location: Southwestern portion of state, joining San Luis Obispo on the south.

Santa Barbara County owes its position as seventh in the state in regard to its mineral output to the presence of productive oil fields within its boundaries. The total value of its mineral production during the year 1916 was $4,535,029, as compared with the 1915 output of $3,984,966. Santa Barbara, in company with the other oil counties, showed an increase in petroleum valuation for 1916.

Aside from the mineral substances listed below, Santa Barbara County contains asphalt, diatomaceous earth, gilsonite, gypsum, magnesite, and quicksilver in more or less abundance.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Mineral water	176,608 gals.	$110,200
Natural gas	3,660,410 M. cu. ft.	724,746
Petroleum	4,502,206 bbls.	3,574,752
Sandstone	3,520 cu. ft.	1,017
Stone, miscellaneous		12,395
Other minerals*		111,919
Total		$4,535,029

*Includes bituminous rock, brick, "granite," diatomaceous earth, limestone and quicksilver.

SANTA CLARA.

Area: 1,328 square miles.

Population: 90,000 (estimate by board of supervisors, 1914).

Location: West central portion of state.

Santa Clara County reported a mineral output for 1916 of $851,948 as compared with the 1915 figures of $635,229. This county, lying largely in the Coast Range of mountains, contains a wide variety of mineral substances, including brick, chromite, clay, limestone, magnesite, manganese, mineral water, petroleum, quicksilver, soapstone, and miscellaneous stone. It stood second in quicksilver yield for the year.

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In twenty-seventh place, commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	136 tons	$2,028
Brick	13,100 M.	82,800
Clay (pottery)	2,024 tons	2,293
Magnesite	23,207 tons	232,156
Mineral water	50,000 gals.	11,300
Petroleum	16,368 bbls.	10,901
Quicksilver	4,016 flasks	375,496
Stone, miscellaneous		111,974
Other minerals*		23,000
Total		$851,948

*Includes limestone and manganese.

SANTA CRUZ.

Area: 435 square miles.

Population: 30,140 (estimate by Chamber of Commerce, 1914).

Location: Bordering Pacific Ocean, just south of San Mateo County.

The mineral output of Santa Cruz County, a portion of which is itemized below, amounted to a total value of $1,679,111, giving the county a standing of fourteenth among all others in the state in this regard, being an increase from the previous year's total.

Among the mineral resources known here are bituminous rock, cement, coal, graphite, gold, lime, limestone, petroleum, silver, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Lime	176,263 bbls.	$225,485
Limestone	4,318 tons	9,820
Stone, miscellaneous		2,815
Other minerals*		1,440,991
Total		$1,679,111

*Includes bituminous rock, cement and marble.

SHASTA.

Area: 3,858 square miles.

Population: 19,000 (estimate by County Clerk, 1914).

Location: North central portion of state.

Shasta County stands second in California among the mineral-producing counties, with an output valued at $13,639,508, as compared with the 1915 production, worth $8,350,133. Not taking petroleum

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into account, Shasta leads all the counties by a wide margin. This county is first in copper production, first in silver, first in pyrite, first in zinc, and seventh in gold. The Shasta copper belt contains the most important deposits of this metal yet developed on the Pacific coast, and the present production could be further increased were it not for the conflict between the agricultural interests and the smelters regarding the alleged damage done to crops by the smelter fumes. The situation is showing improvement.

Shasta's mineral resources include: Asbestos, barytes, brick, chromite, coal, copper, gold, iron, lead, lime, limestone, mineral water, molybdenum, pyrite, silver, miscellaneous stone, and zinc.

Lassen Peak is located in southeastern Shasta County.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	12,425 tons	$181,225
Copper	39,437,196 lbs.	9,701,550
Gold		936,885
Lead	478,560 lbs.	33,021
Lime and limestone		57,303
Silver		1,115,471
Zinc	9,484,800 lbs.	1,270,963
Stone, miscellaneous		800
Other minerals*		342,290
Total		$13,639,508

*Includes asbestos, brick, iron ore, manganese, mineral water, platinum, pyrite and silica.

SIERRA.

Area: 923 square miles.

Population: 4,098 (1910 census).

Location: Eastern border of state, just north of Nevada county.

Sierra County reported a mineral production of $729,497, consisting mainly of gold and silver, during the year 1916, as compared with the 1915 output, worth $729,518. Considering gold output alone, this county stands tenth; and as to total mineral yield, twenty-ninth.

Aside from the metals itemized below, Sierra County contains deposits of asbestos, chromite, iron, lead, platinum minerals, serpentine, and talc.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Gold		$724,256
Silver		3,291
Other minerals		1,950
Total		$729,497

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SISKIYOU.

Area: 6,256 square miles.

Population: 25,000 (estimate by County Clerk, 1914).

Location: Extreme north central portion of state, next Oregon boundary.

Siskiyou, fifth county in California in regard to size, located in a highly mineralized and mountainous country, ranks thirtieth in regard to the value of its mineral output for 1916. Although the county is traversed by a transcontinental railroad in a north and south line, the mineral-bearing sections are almost without exception far from transportation and other facilities. A large part of the county is accessible by trail alone. Future development and exploitation will doubtless increase the productiveness of this part of the state to a great degree.

Among Siskiyou's mineral resources are: Chromite, clay, coal, copper, gems, gold, lead, limestone, manganese, marble, mineral water, pumice, quicksilver, sandstone, silver, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	2,251 tons	$28,731
Gold		441,307
Mineral water	502,650 gals.	50,530
Silver		2,312
Stone, miscellaneous		45,407
Other minerals*		12,609
Total		$580,896

*Includes copper, "granite" (basalt), lime, platinum and sandstone.

SOLANO.

Area: 822 square miles.

Population: 31,000 (estimate by Chamber of Commerce, 1914).

Location: Touching San Francisco Bay on the northeast.

Solano, while mostly valley land, produced mineral substances during the year 1916 to the total value of $1,205,335, ranking twentieth among the counties of the state. Among her mineral resources are: Brick, cement, clay, fuller's earth, limestone, mineral water, natural gas, onyx, petroleum, quicksilver, salt, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Mineral water	11,200 gals.	$3,750
Quicksilver	660 flasks	61,710
Stone, miscellaneous		49,711
Other minerals*		1,090,164
Total		$1,205,335

*Includes cement, natural gas and salt.

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SONOMA.

Area: 1,577 square miles.

Population: 48,394 (1910 census).

Location: South of Mendocino County, bordering on the Pacific Ocean.

Sonoma ranked thirty-second among the counties of California during the year 1916, with a mineral production of $472,048, as compared with its 1915 output worth $276,104. More paving blocks are turned out here than in any other section of the state.

Among Sonoma's mineral resources are: Brick, chromite, clay, copper, graphite, infusorial earth, magnesite, manganese, marble, mineral paint, mineral water, quicksilver, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	243 tons	$2,478
Magnesite	11,653 tons	98,280
Mineral water	121,366 gals.	28,031
Quicksilver	1,039 flasks	97,146
Stone, miscellaneous		232,113
Other minerals*		14,000
Total		$472,048

*Includes "granite" (tuff), and manganese.

STANISLAUS.

Area: 1,450 square miles.

Population: 30,000 (estimate by Board of Trade, 1914).

Location: Center of state, bounded on south by Merced County.

Gold is the chief mineral product of Stanislaus County, although brick, clay, gypsum, iron, manganese, mineral paint, quicksilver, and silver are found here to some extent as well. This county, for 1916, ranks thirty-seventh in the state in regard to value of minerals, with an output of $253,022. In order not to reveal individual business, the gold, platinum, and silver yields of its single dredge are combined with the data of other minerals.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Manganese	160 tons	$2,400
Mineral paint	507 tons	2,200
Stone, miscellaneous		17,784
Other minerals*		230,638
Total		$253,022

*Includes chromite, brick, gold, platinum, quicksilver and silver.

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SUTTER.

Area: 608 square miles.

Population: 9,375 (estimate by County Clerk, 1914).

Location: Bounded by Butte County on the north and Sacramento on the south.

Sutter is one of only two counties in the state which for a number of years reported no commercial output of some kind of mineral substance. In 1916 some crushed rock was taken out, from the Marysville Buttes, as indicated below. Both clay and coal exist here, but deposits of neither mineral have been placed on a productive basis.

Substance	Amount	Value
Stone, miscellaneous		$6,450

TEHAMA.

Area: 2,893 square miles.

Population: 14,575 (estimate by County Clerk, 1914).

Location: North central portion of the state, bounded on the north by Shasta.

Tehama stands fiftieth among the fifty-seven mineral-producing counties of the state. Its mineral output during 1916 was valued at $54,353, as compared with the 1915 production, worth $4,702. The advance is due mainly to chromite.

Among its mineral resources are listed: Brick, chromite, copper, gold, manganese, marble, mineral water, salt, silver, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	1,896 tons	$39,702
Stone, miscellaneous		11,076
Other minerals*		3,575
Total		$54,353

*Includes brick, granite, mineral water and natural gas.

TRINITY.

Area: 3,166 square miles.

Population: 3,301 (1910 census).

Location: Northwestern portion of state.

Trinity, like Siskiyou County, requires transportation facilities to further the development of its many and varied mineral resources.

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Deposits of asbestos, barytes, chromite, copper, gold, mineral water, platinum, quicksilver, silver, and building stone are known here, but with the exception of gold and copper, very little active production of these mineral substances is possible, as yet.

In twenty-eighth place, commercial output for 1916 was:

Substance	Amount	Value
Gold		$435,493
Platinum	113 ounces	5,161
Silver		7,591
Stone, miscellaneous		1,000
Other minerals*		397,316
Total		$846,561

*Includes chromite, copper, manganese, mineral water and quicksilver.

TULARE.

Area: 4,856 square miles.

Population: 35,440 (1910 census).

Location: Bounded by Inyo on the east, Kern on the south, Fresno on the north.

Tulare stands twenty-sixth on the list of mineral-producing counties. Her mineral resources, among others, are: Brick, clay, copper, feldspar, graphite, gems, limestone, magnesite, marble, quartz, glass-sand, soapstone, miscellaneous stone, and zinc. Tulare leads the state in magnesite output, and to this is due her advance in 1916.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	3,435 tons	$42,555
Brick	6,330 M.	48,500
Copper	1,422 lbs.	350
Magnesite	87,606 tons	737,130
Stone, miscellaneous		82,255
Other minerals*		36,410
Total		$947,200

*Includes feldspar, granite, limestone, marble and silica.

TUOLUMNE.

Area: 2,190 square miles.

Population: 9,979 (1910 census).

Location: East central portion of state—Mother Lode district.

Tuolumne ranks twenty-fifth among the counties of the state relative to its total value of mineral output. As a producer of marble its standing is first.

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Chromite, clay, copper, gold, lead, limestone, marble, mineral paint, platinum, soapstone, silver, and miscellaneous stone, are among its mineral resources.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Chromite	285 tons	$4,556
Copper	1,797 lbs.	442
Gold		868,237
Lead	873 lbs.	60
Limestone	3,137 tons	5,132
Silver		17,039
Stone, miscellaneous		1,500
Other minerals*		107,296
Total		$1,004,262

*Includes dolomite, lime, magnesite and marble.

VENTURA.

Area: 1,878 square miles.

Population: 21,000 (estimate by Chamber of Commerce, 1914).

Location: Southwestern portion of state, bordering on Pacific Ocean.

Ventura is the twenty-first county in the state in respect to the value of its mineral production for 1916, the exact figure being $1,135,430, as compared with the output for 1915, worth $904,767.

The highest gravity petroleum produced in the state is found here.

Among its other mineral resources are: Asphalt, borax, brick, clay, mineral water, natural gas, sandstone, and miscellaneous stone.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Natural gas	806,540 M. cu. ft.	$133,867
Petroleum	943,499 bbls.	985,956
Stone, miscellaneous		14,200
Other minerals*		1,407
Total		$1,135,430

*Includes brick, clay and sandstone.

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YOLO.

Area: 1,014 square miles.

Population: 15,000 (estimate by County Clerk, 1914).

Location: Sacramento Valley, bounded by Sutter on the east and Colusa on the north.

The mineral production from Yolo County during the year 1916 consisted only of miscellaneous stone valued at $300, ranking it in fifty-seventh place. Deposits of undetermined value of iron and sandstone have been discovered within the confines of this county. Some quicksilver output has been made in the past, and may resume.

Commercial production for 1916 was as follows:

Substance	Amount	Value
Stone, miscellaneous		$300

YUBA.

Area: 639 square miles.

Population: 14,750 (estimate by County Clerk, 1914).

Location: Lies west of Sierra and Nevada counties; south of Plumas.

Yuba is eleventh of the fifty-seven mineral producing counties of the state, and is third in regard to gold output. Quicksilver and iron deposits have been reported in this county, aside from the following commercial production as reported for the year 1916:

Substance	Amount	Value
Copper	4,817 lbs.	$1,185
Gold		3,167,723
Platinum	314 ounces	14,301
Silver		5,934
Stone, miscellaneous		42,685
Other minerals		6,000
Total		$3,237,828

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CHAPTER EIGHT.

APPENDIX.

MINING BUREAU ACT.

Chapter 679.

[Stats., 1913.]

An act establishing a state mining bureau, creating the office of state mineralogist, fixing his salary and prescribing his powers and duties; providing for the employment of officers and employees of said bureau, making it the duty of persons in charge of mines, mining operations and quarries to make certain reports, providing for the investigation of mining operations, dealings and transactions and the prosecution for defrauding, swindling and cheating therein, creating a state mining bureau fund for the purpose of carrying out the provisions of this act and repealing an act entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, who shall have the direction, management and control of said state mining bureau, and to provide for the appointment, duties, and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, and all acts amendatory thereof and supplemental thereto or in conflict herewith.

[Approved June 16, 1913. In effect August 10, 1913.]

The people of the state of California do enact as follows:

SECTION 1. There is hereby created and established a state mining bureau. The chief officer of such bureau shall be the state mineralogist, which office is hereby created.

SEC. 2. It shall be the duty of the governor of the state of California and he is hereby empowered to appoint a citizen and resident of this state, having a practical and scientific knowledge of mining, to the office of state mineralogist. Said state mineralogist shall hold his office at the pleasure of the governor. He shall be a civil executive officer. He shall take and subscribe the same oath of office as other state officers. He shall receive for his services a salary of three hundred dollars ($300) per month, to be paid at the same time and in the same manner as the salaries of other state officers. He shall also receive his necessary traveling expenses when traveling on the business of his office. He shall give bond for the faithful performance of his duties in the sum of ten thousand dollars ($10,000), said bond to be approved by the governor of the state of California.

SEC. 3. Said state mineralogist shall employ competent geologists, field assistants, qualified specialists and office employees when necessary in the execution of his plans and operations of the bureau, and fix their compensation. The said employees shall be allowed their necessary traveling expenses when traveling on the business of said department and shall hold office at the pleasure of said state mineralogist.

SEC. 4. It shall be the duty of said state mineralogist to make, facilitate, and encourage, special studies of the mineral resources and mineral industries of the state. It shall be his duty: to collect statistics concerning the occurrence and production of the economically important minerals and the methods pursued in making their valuable constituents available for commercial use; to make a collection of typical geological and mineralogical specimens, especially those of economic and commercial importance, such collection constituting the museum of the state mining bureau; to provide a library of books, reports, drawings, bearing upon the mineral industries, and sciences of mineralogy and geology, and arts of mining and metallurgy, such library constituting the library of the state mining bureau; to make a collection of models, drawings and descriptions of the mechanical appliances used

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in mining and metallurgical processes; to preserve and so maintain such collections and library as to make them available for reference and examination, and open to public inspection at reasonable hours; to maintain, in effect, a bureau of information concerning the mineral industries of this state, to consist of such collections and library, and to arrange, classify, catalogue, and index the data therein contained, in a manner to make the information available to those desiring it; to issue from time to time such bulletins as he may deem advisable concerning the statistics and technology of the mineral industries of this state.

SEC. 5. It is hereby made the duty of the owner, lessor, lessee, agent, manager or other person in charge of each and every mine, of whatever kind or character, within the state, to forward to the state mineralogist, upon his request, at his office not later than the thirtieth day of June, in each year, a detailed report upon forms which will be furnished showing the character of the mine, the number of men then employed, the method of working such mine and the general condition thereof, the total mineral production for the past year, and such owner, lessor, lessee, agent, manager or other person in charge of any mine within the state must furnish whatever information relative to such mine as the state mineralogist may from time to time require for the proper discharge of his official duties. Any owner, lessor, lessee, agent, manager or other person in charge of each and every mine, of whatever kind or character within the state, who fails to comply with the above provisions shall be deemed guilty of a misdemeanor.*

SEC. 6. The state mineralogist now performing the duties of the office of state mineralogist shall perform the duties of the office of state mineralogist as in this act provided until the appointment and qualification of his successor as in this act provided.

SEC. 7. The said state mineralogist shall take possession, charge and control of the offices now occupied and used by the board of trustees and state mineralogist and the museum, library and laboratory of the mining bureau located in San Francisco as provided for by a certain act of the legislature approved March 23, 1893, and hereafter referred to in section fourteen hereof, and shall maintain such offices, museum, library and laboratory for the purposes provided in this act.

SEC. 8. Said state mineralogist or qualified assistant shall have full power and authority at any time to enter or examine any and all mines, quarries, wells, mills, reduction works, refining works and other mineral properties or working plants in this state in order to gather data to comply with the provisions of this act.

SEC. 9. The state mineralogist shall make a biennial report to the governor on or before the fifteenth day of September next preceding the regular session of the legislature.

SEC 10. All moneys received by the state mining bureau or any officer thereof (except such as may be paid to them by the state for disbursement) shall be receipted for by the state mineralogist or other officer authorized by him to act in his place and at least once a month accounted for by him to the state controller and paid into the state treasury to the credit of a fund which is hereby created and designated "state mining bureau fund." All moneys now in the possession of the state mining bureau or any officer thereof received from any source whatsoever, shall be immediately paid over to the state mineralogist and by him accounted for to the controller and paid into the state treasury to the credit of said fund. Said fund shall be used and is hereby appropriated for the use of said bureau in carrying out the purposes of this act.

SEC. 11. The said state mineralogist is hereby authorized and empowered to receive on behalf of this state, for the use and benefit of the state mining bureau, gifts, bequests, devices and legacies of real or other property and to use the same in accordance with the wishes of the donors, and if no instructions are given by said donors, to manage, use, and dispose of the gifts and bequests and legacies for the best interests of said state mining bureau and in such manner as he may deem proper.

*Sec. 19 of the Penal Code of California provides: "Except in cases where a different punishment is prescribed by this code, every offense declared to be a misdemeanor is punishable by imprisonment in a county jail not exceeding six months, or by a fine not exceeding five hundred dollars, or by both."

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SEC. 12. The state mineralogist may, whenever he deems it advisable, prepare a special collection of ores and minerals of California to be sent to or used at any world's fair or exposition in order to display the mineral wealth of the state.

SEC. 13. The state mineralogist is hereby empowered to fix a price upon and to dispose of to the public, at such price, any and all publications of the state mining bureau, including reports, bulletins, maps, registers or other publications, such price shall approximate the cost of publication and distribution. Any and all sums derived from such disposition, or from gifts or bequests made, as hereinbefore provided must be accounted for by said state mineralogist and turned over to the state treasurer to be credited to the mining bureau fund as provided for in section ten. He is also empowered to furnish without cost to public libraries the publications of the bureau, and to exchange publications with other geological surveys and scientific societies, etc.

SEC. 14. The state mineralogist provided for by this act shall be the successor in interest of the board of trustees of the state mining bureau, and the state mineralogist, under and by virtue of that certain act, entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, who shall have the direction, management, and control of said state mining bureau, and to provide for the appointment, duties, and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, and all books, papers, documents, personal property, records, and property of every kind and description obtained or possessed, or held or controlled by the said board of trustees of the said state mining bureau, and the state mineralogist, and the clerks and employees thereof, under the provisions of said act of March 23, 1893, or any act supplemental thereto or amendatory thereof, shall immediately be turned over and delivered to the said state mineralogist herein provided for, who shall have charge and control thereof.

SEC. 15. That certain act entitled "An act to provide for the establishment, maintenance, and support of a bureau, to be known as the state mining bureau, and for the appointment and duties of a board of trustees, to be known as the board of trustees of the state mining bureau, and to provide for the appointment, duties and compensation of a state mineralogist, who shall perform the duties of his office under the control, direction, and supervision of the board of trustees of the state mining bureau," approved March 23, 1893, together with all acts amendatory thereof and supplemental thereto and all acts in conflict herewith are hereby repealed.

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Report	XI.	Wm. Irelan, Jr. 1892. (First biennial)	$1.00
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*Sierra County	----
*Siskiyou County	----
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Register of Oil Wells (with map), Los Angeles City	.35

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*California, Showing Mineral Deposits (50x60 in.)	----
Forest Reserves in California—	
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Unmounted	.30
*Mineral and Relief Map of California	----
El Dorado County, Showing Boundaries of National Forests	.20
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Placer County, Showing Boundaries of National Forests	.20
Shasta County, Showing Boundaries of National Forests	.20
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Tuolumne County, Showing Boundaries of National Forests	.20
*Mother Lode Region	----
Desert Region of Southern California	.10
Minaret District, Madera County	.20
Copper Deposits in California	.05
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Geological Map of California (mounted)—50x60 inches	2.50

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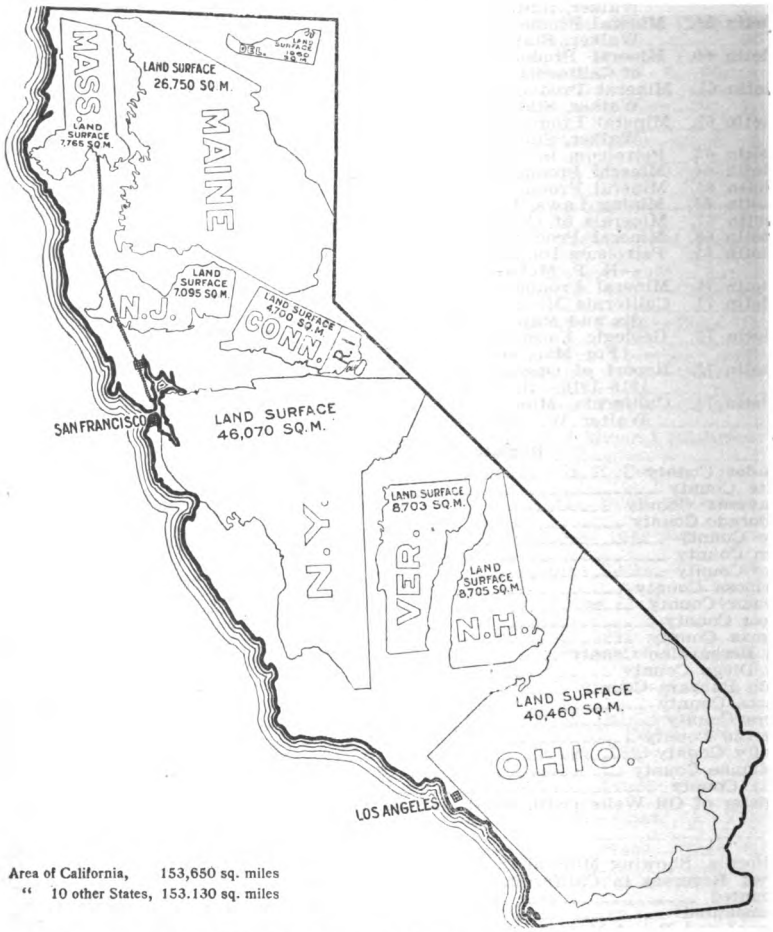
DETERMINATION OF MINERAL SAMPLES.

Samples (limited to three at one time) of any mineral found in the state may be sent to the Bureau for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the state. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.



Outline map of California, showing relative areas of ten other states.

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The following county maps show all towns, post offices, railroads, stage lines, and the highways. They are especially valuable to all who wish to leave the railroad and penetrate to the interior of the mining districts of the state. These maps must not be reproduced without obtaining permission from the Mining Bureau.

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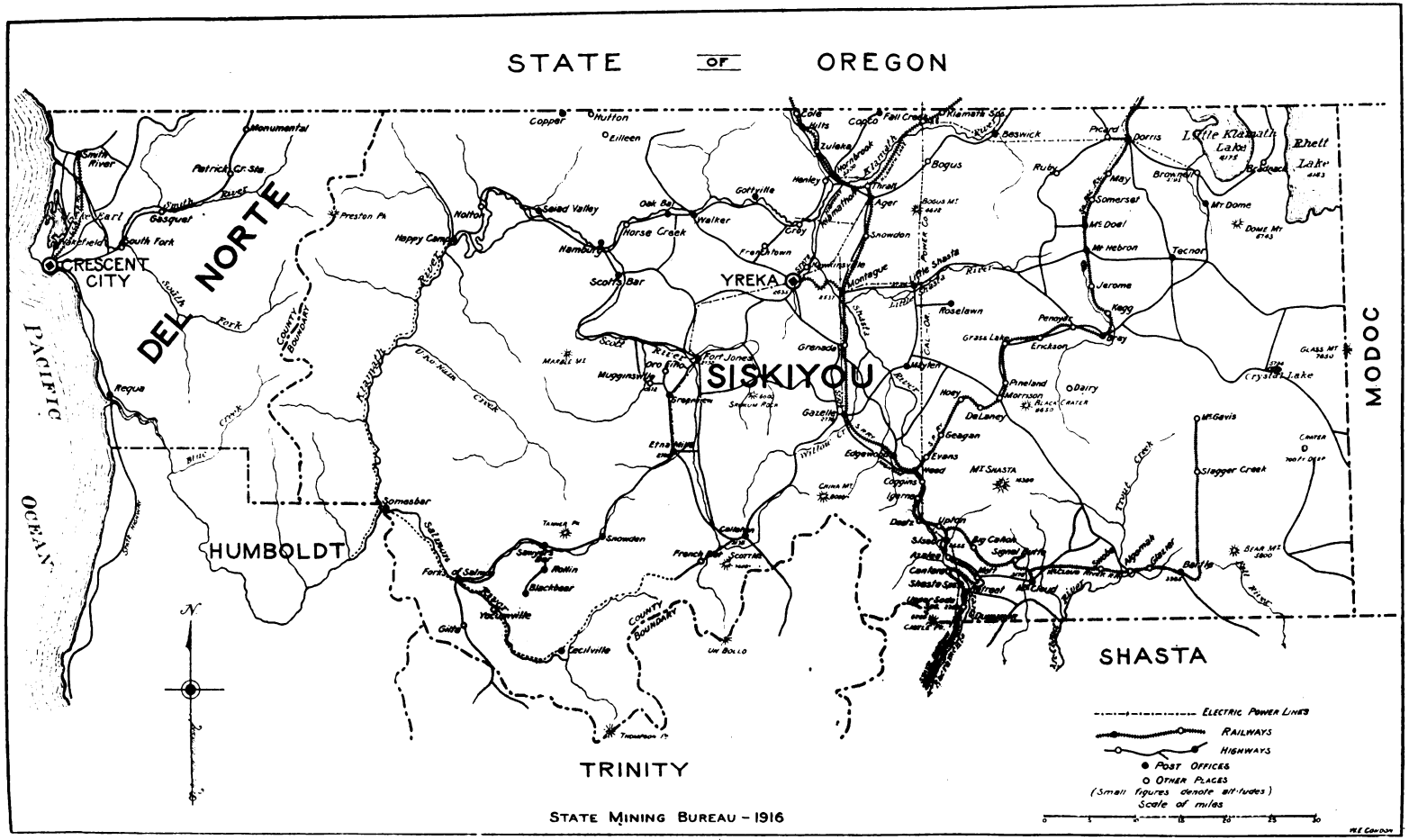

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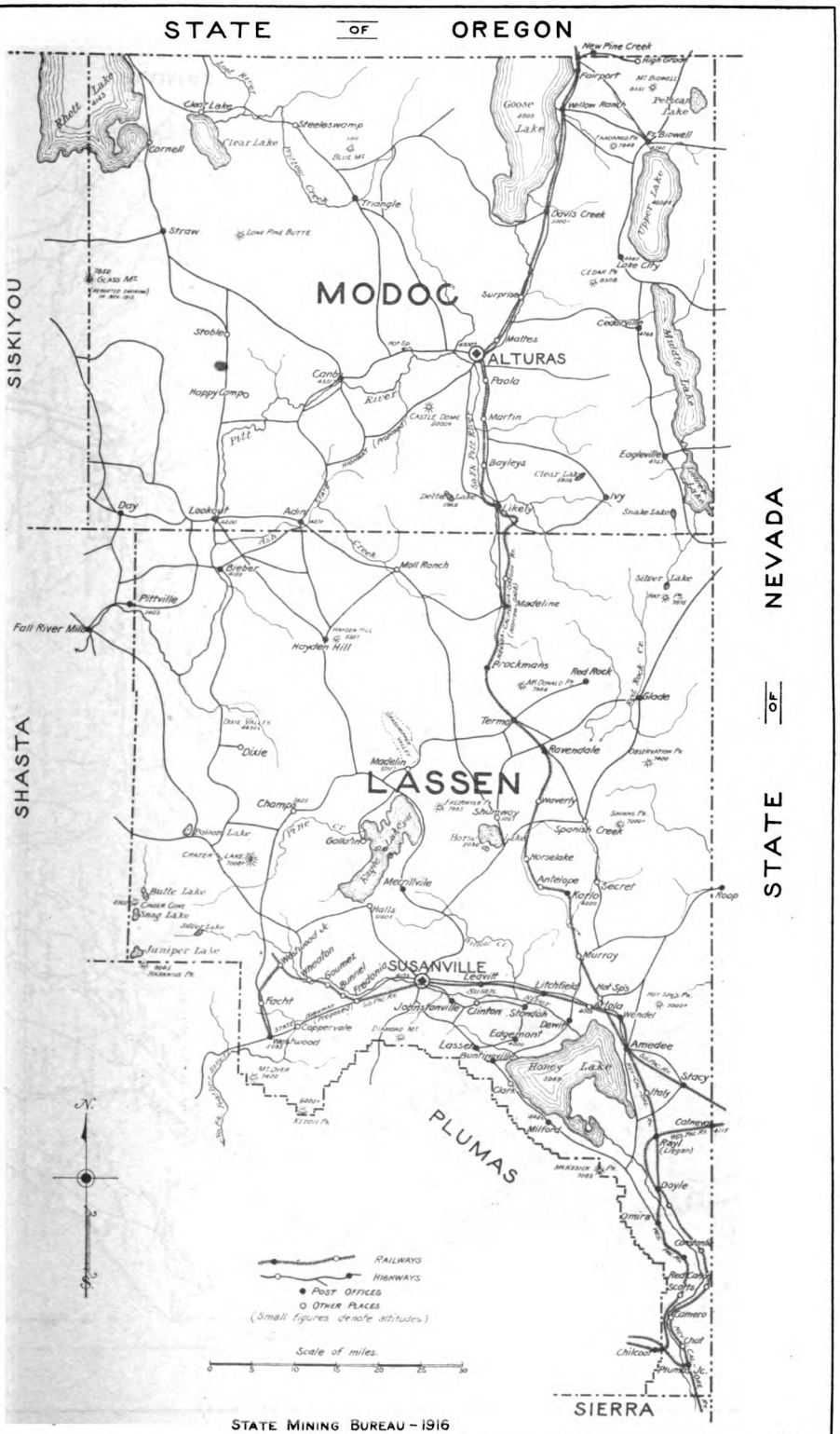

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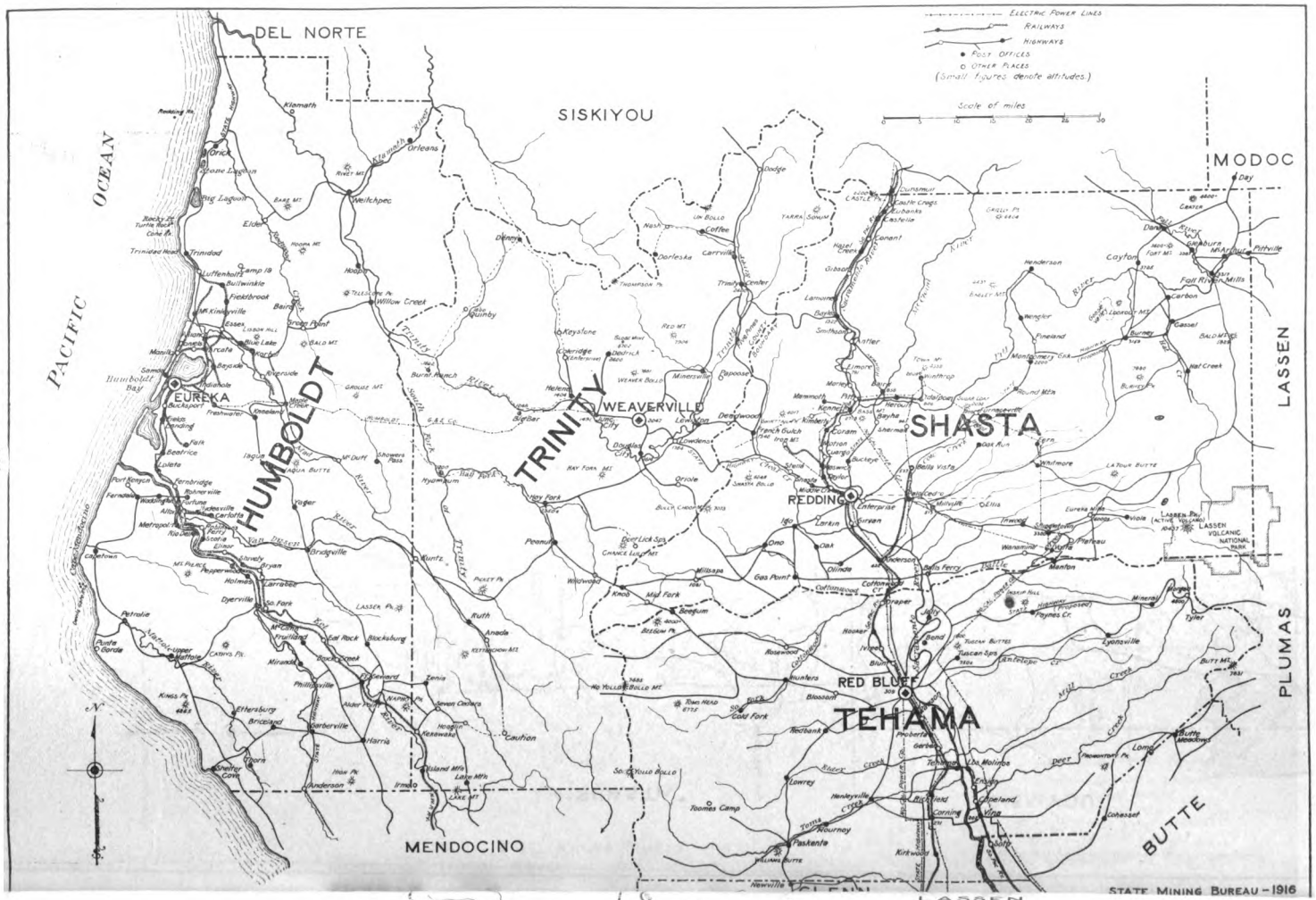

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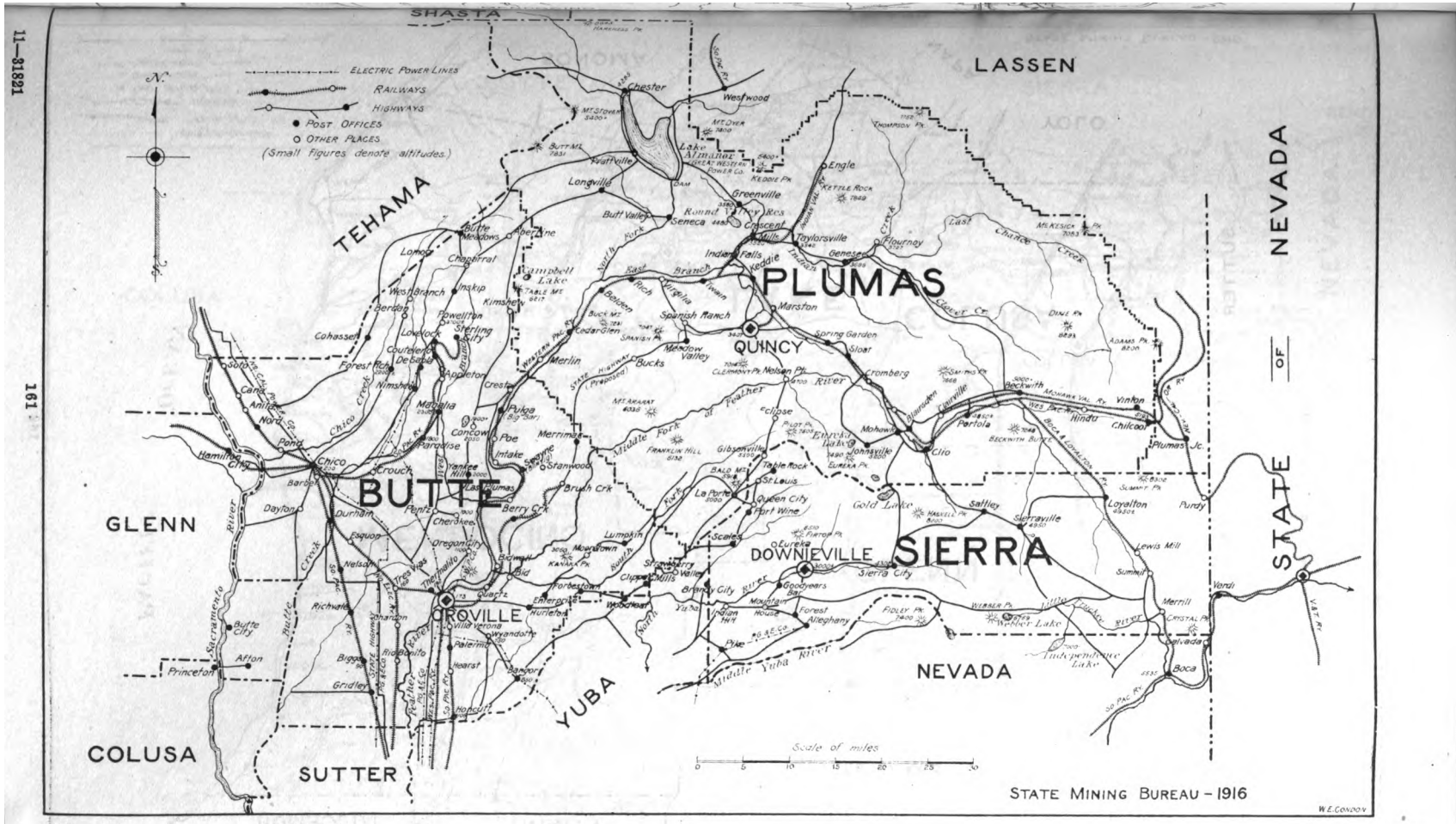

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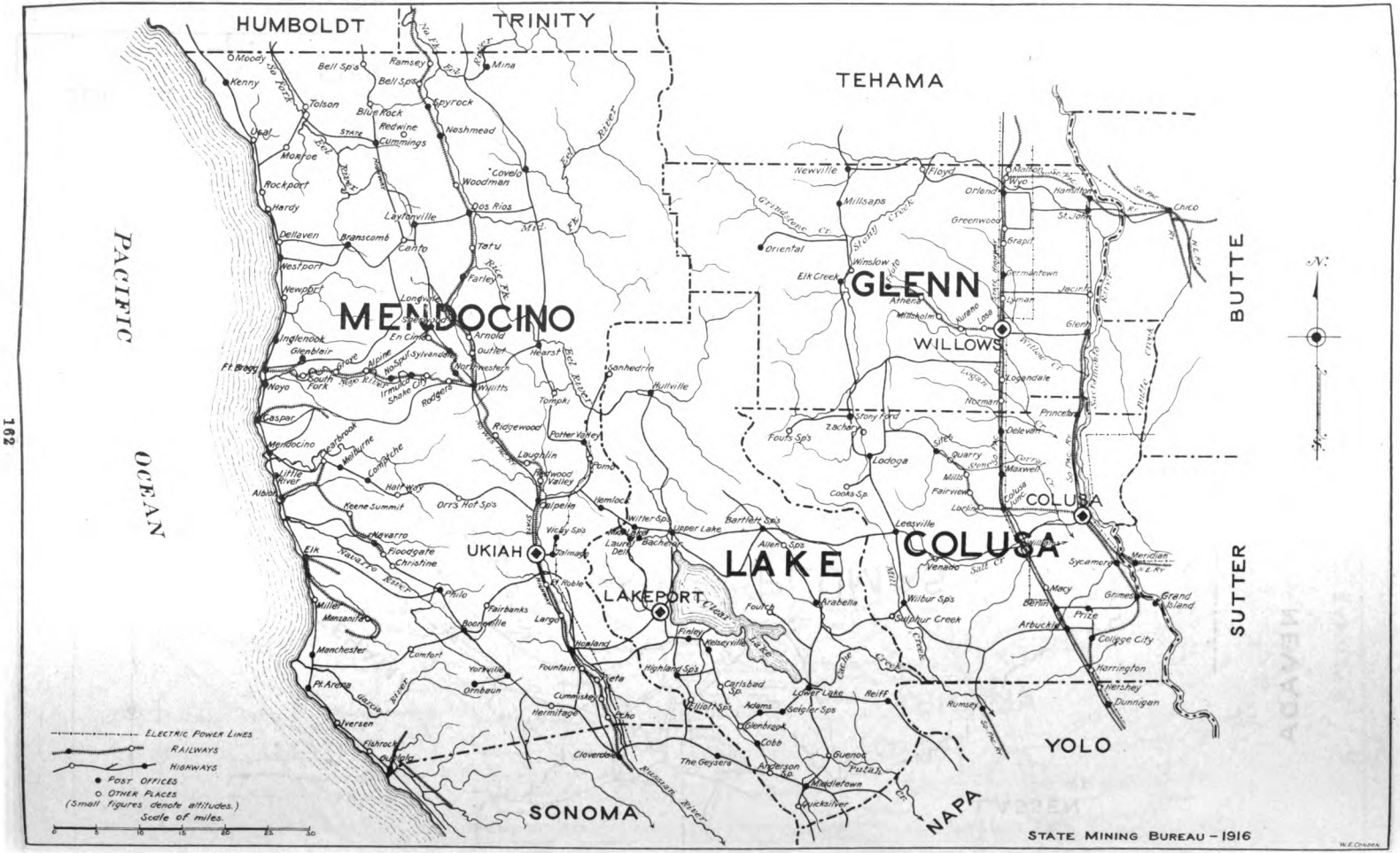

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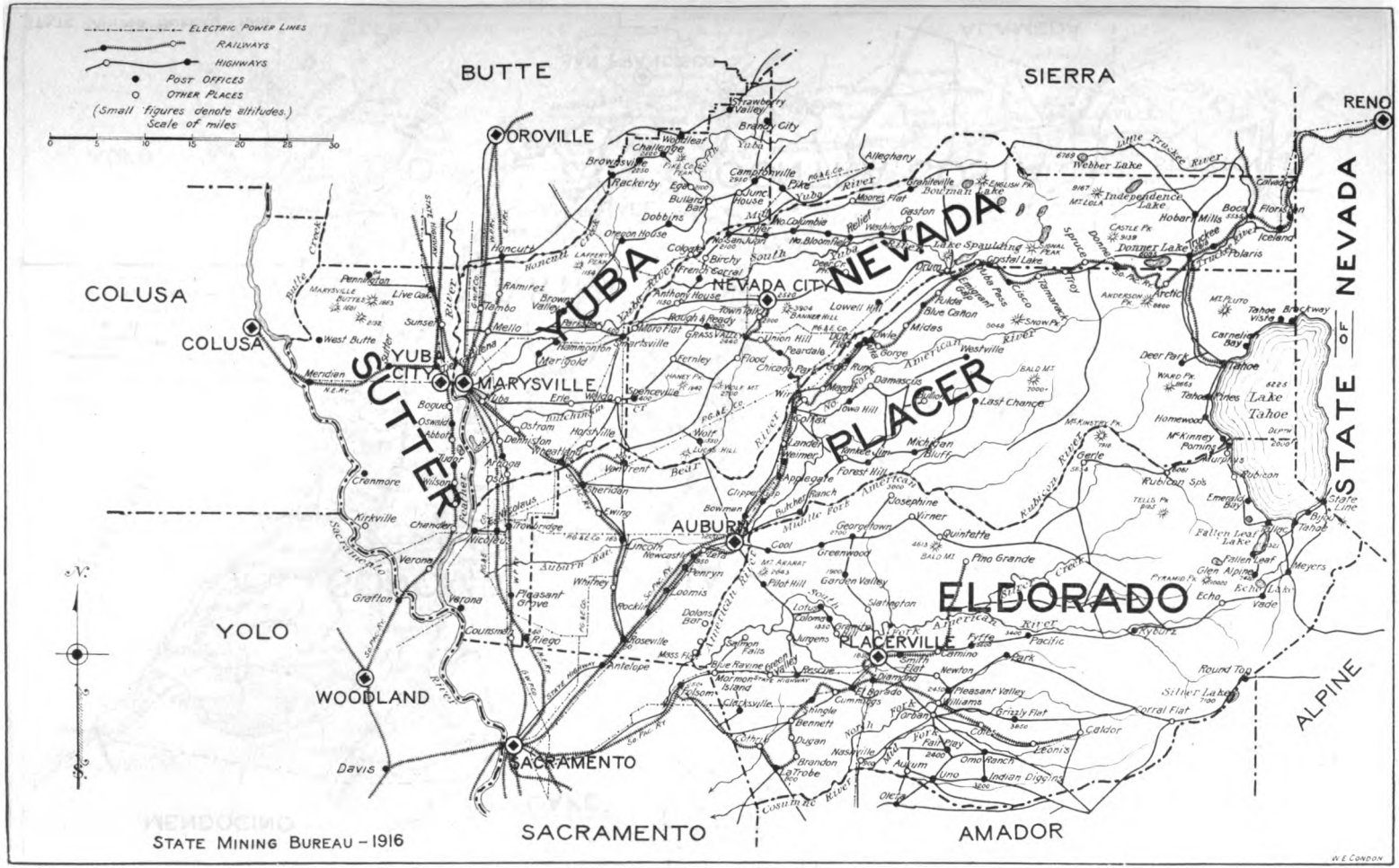

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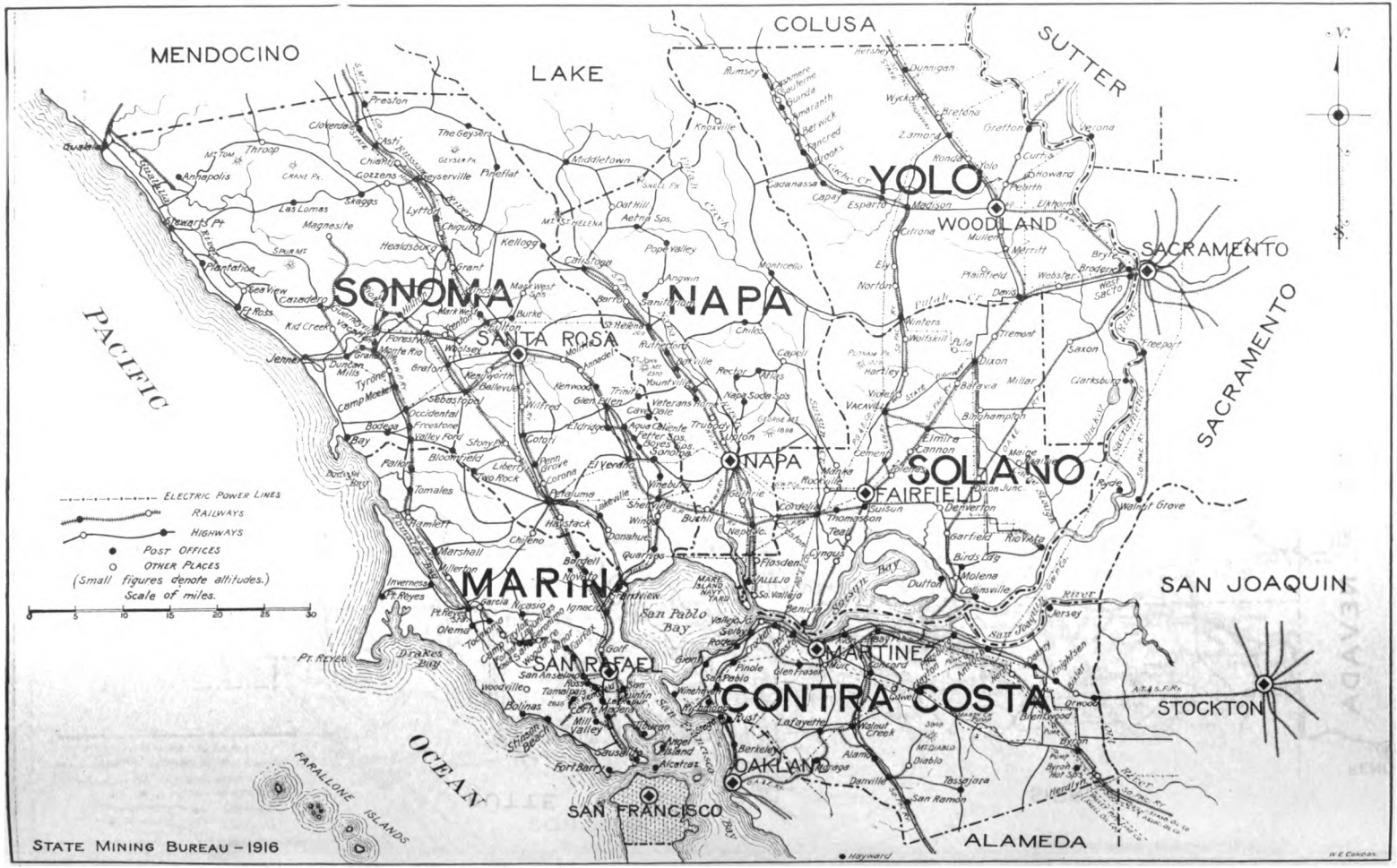

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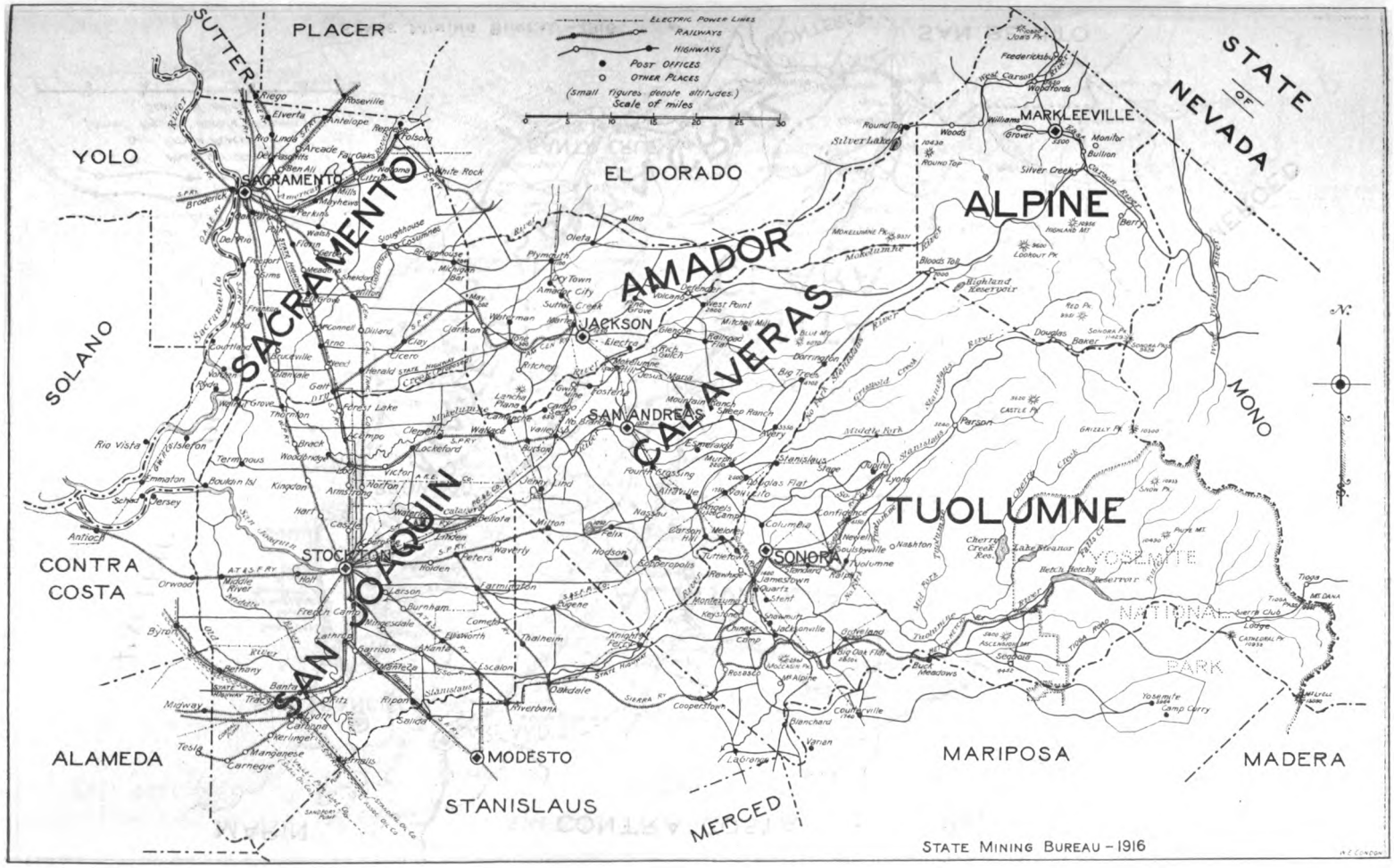

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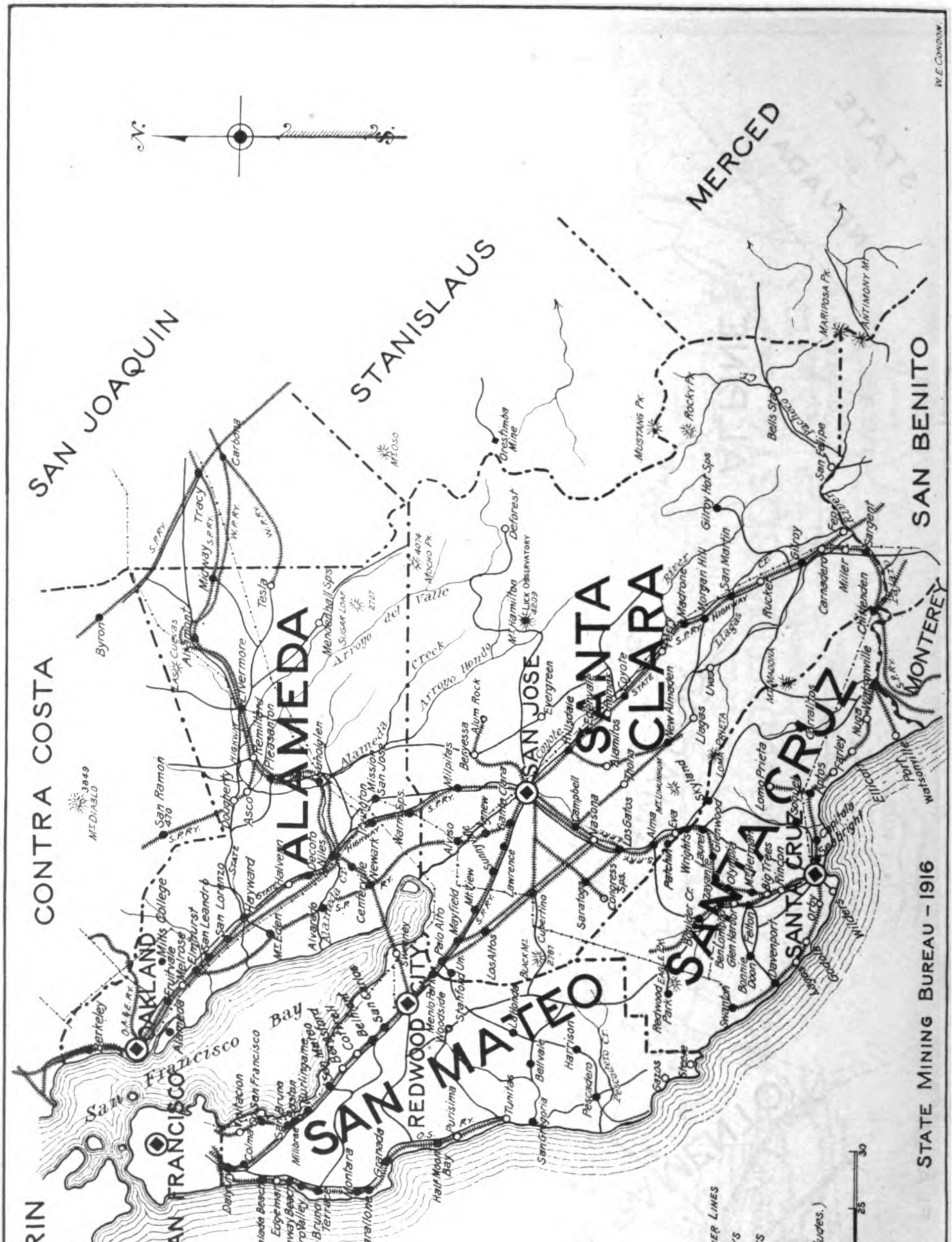

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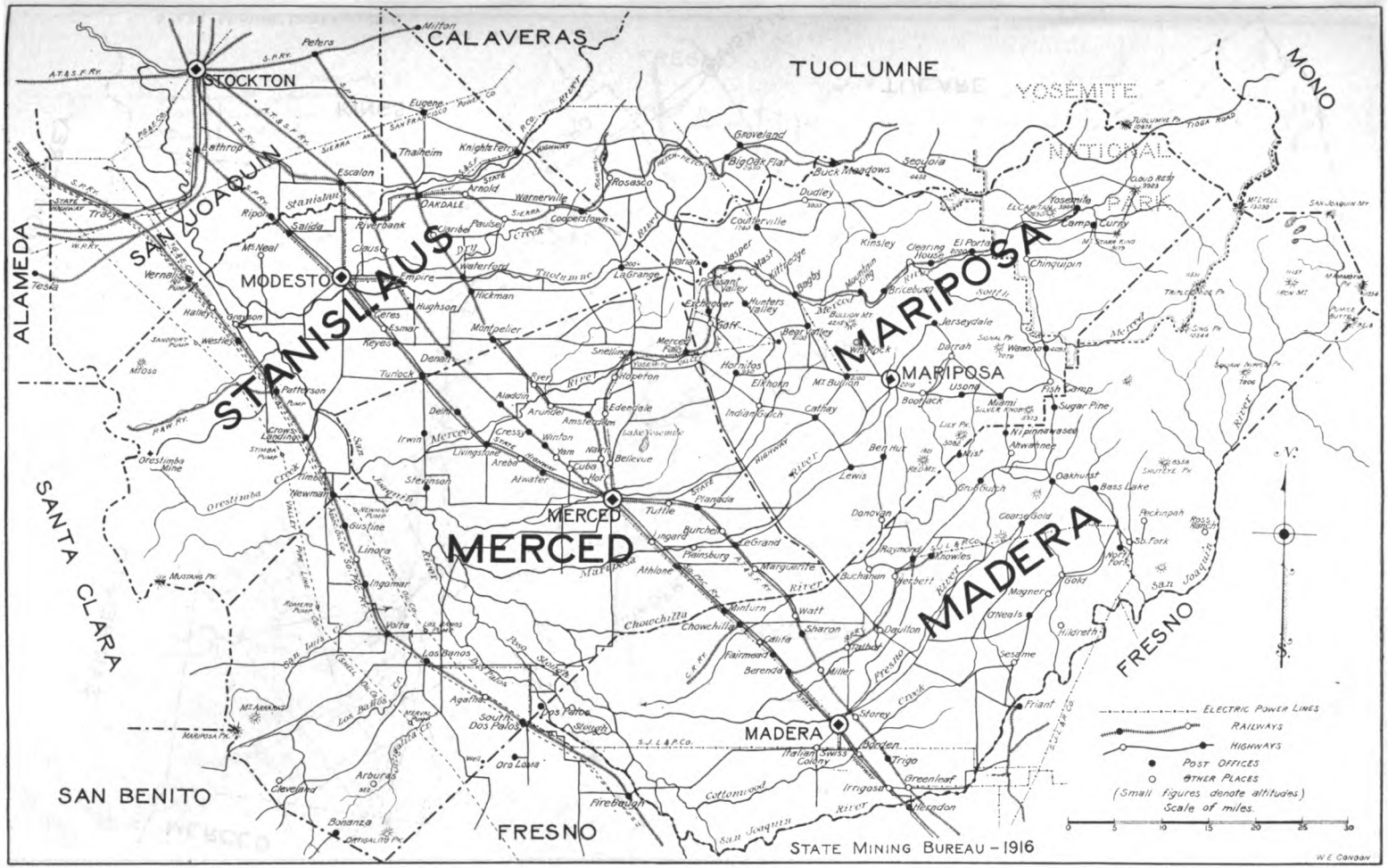

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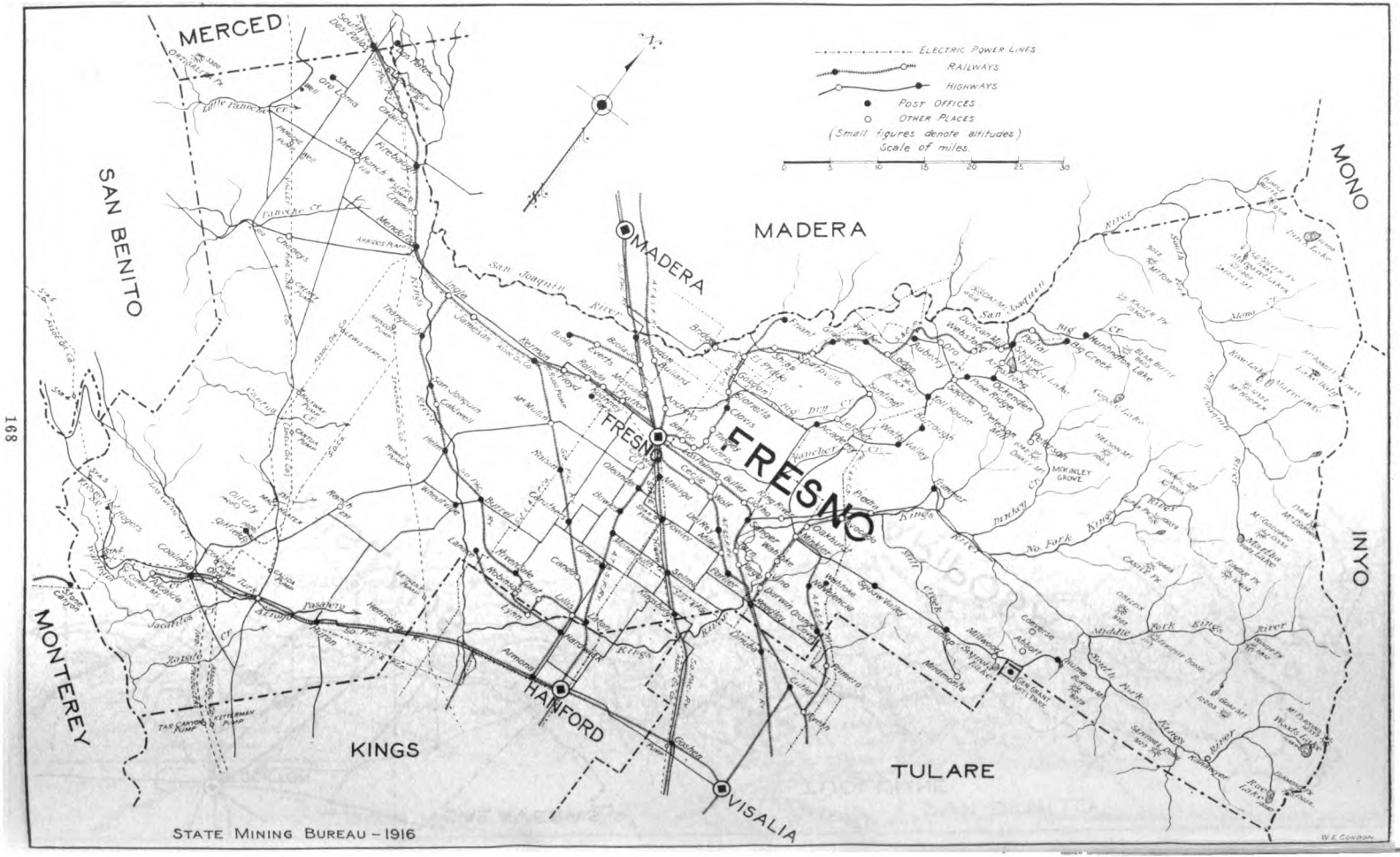

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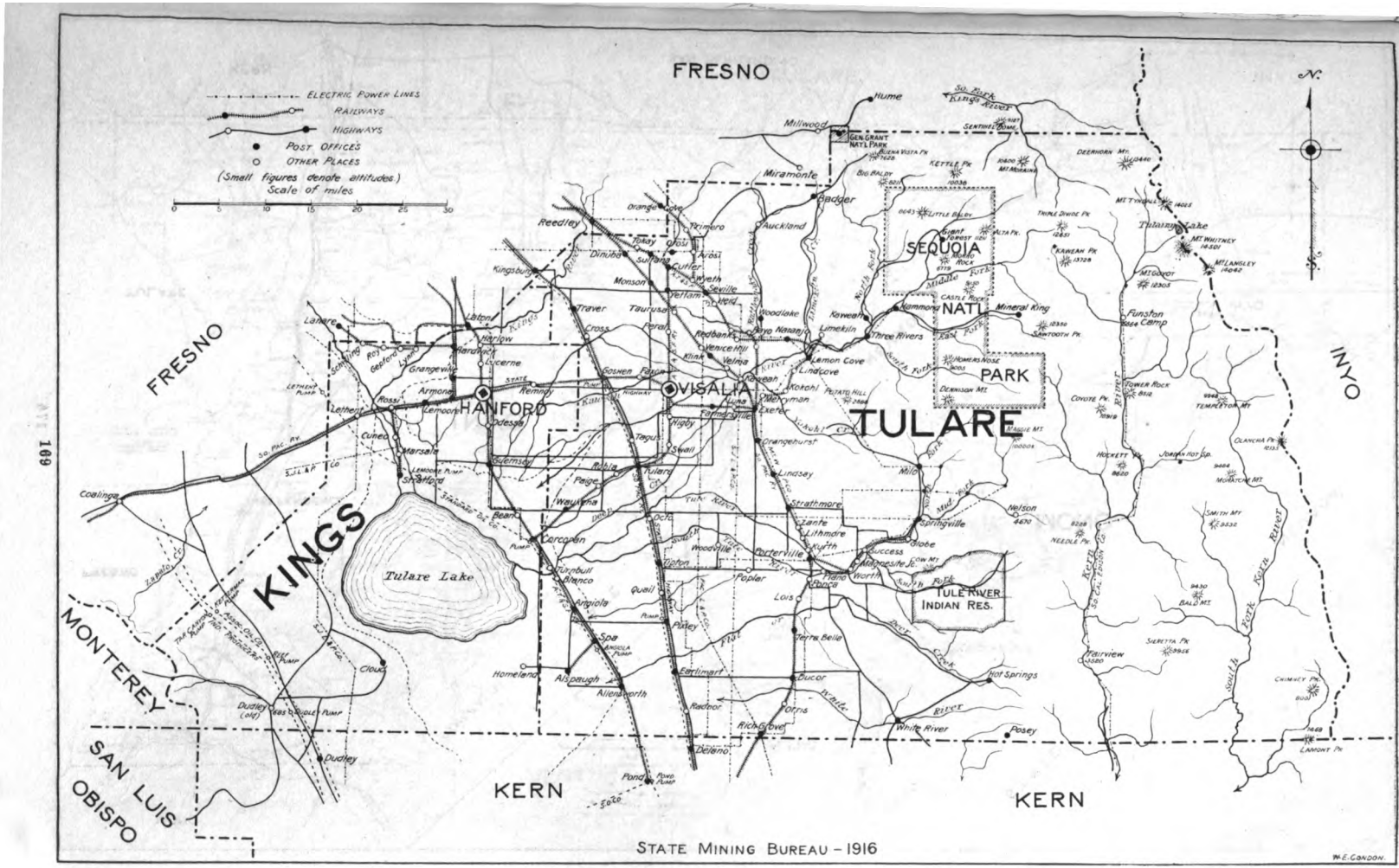

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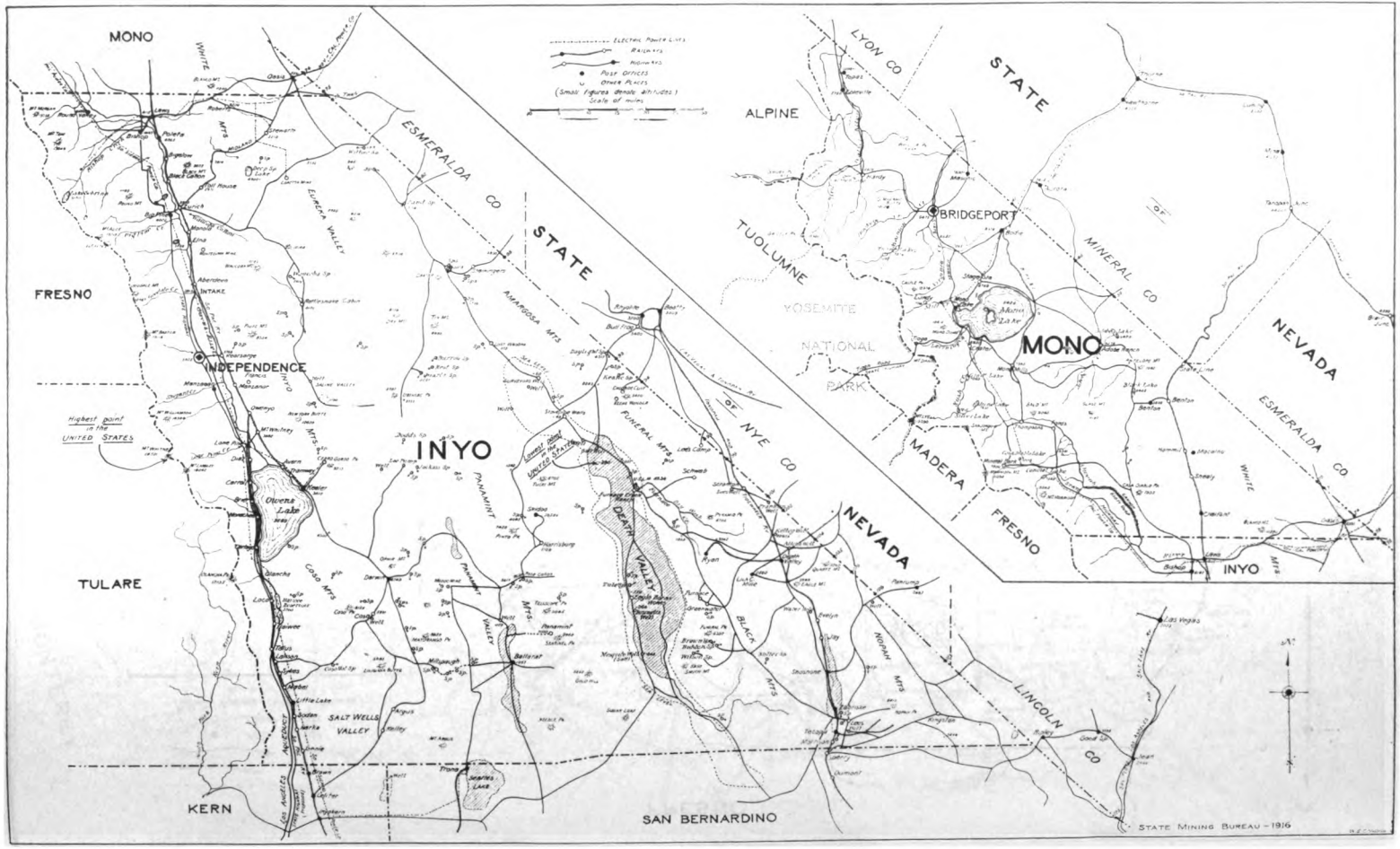

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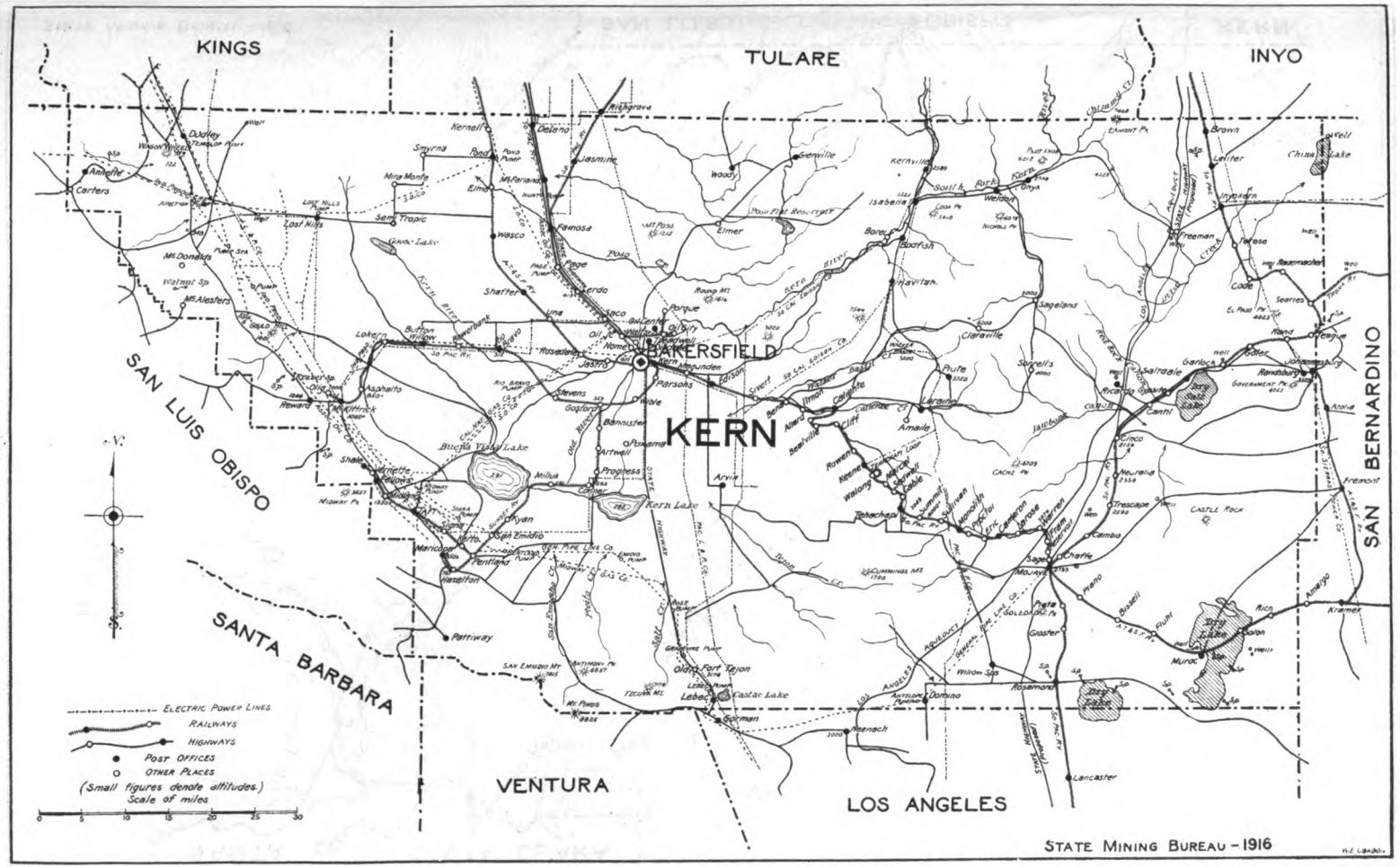

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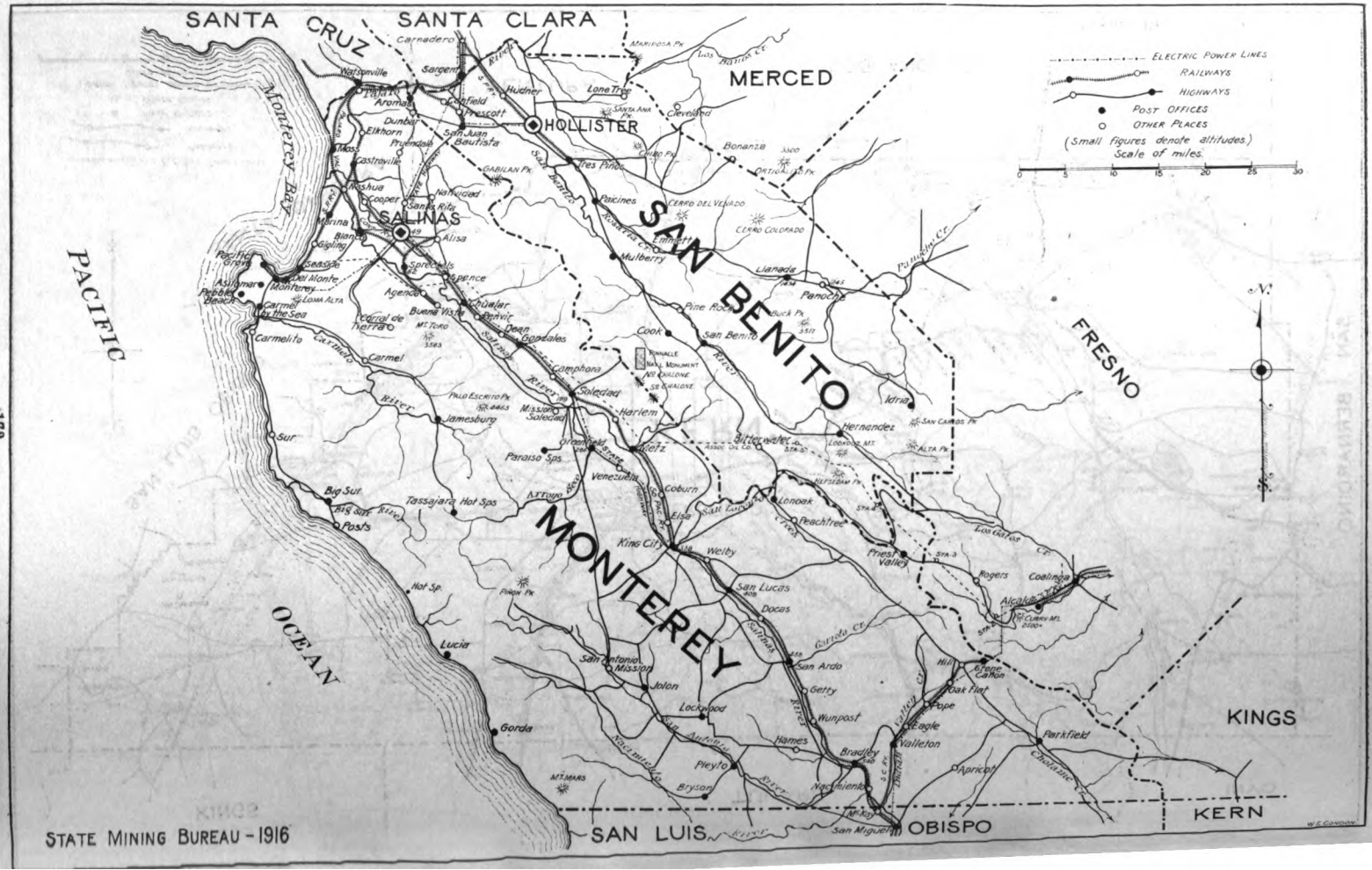

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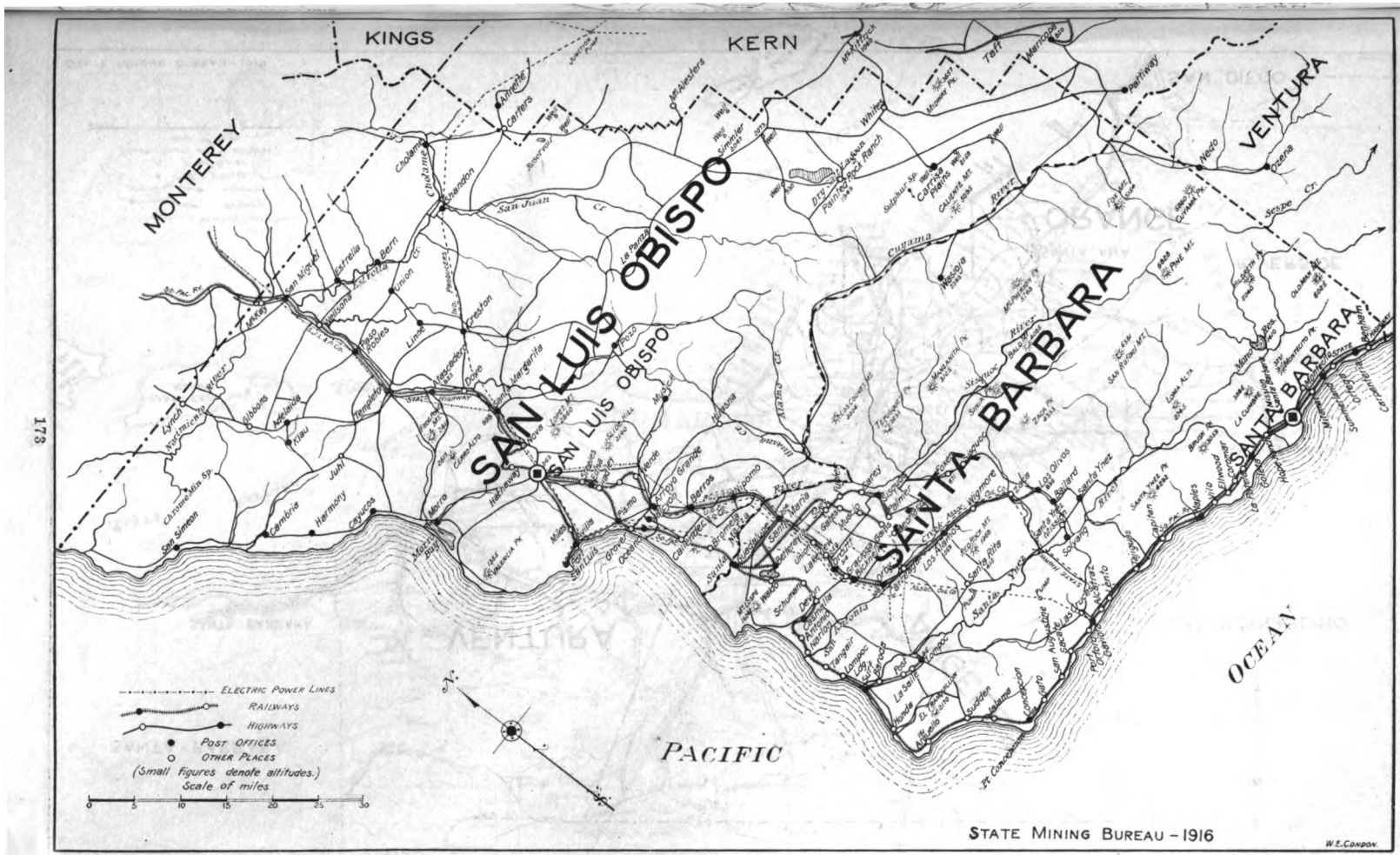

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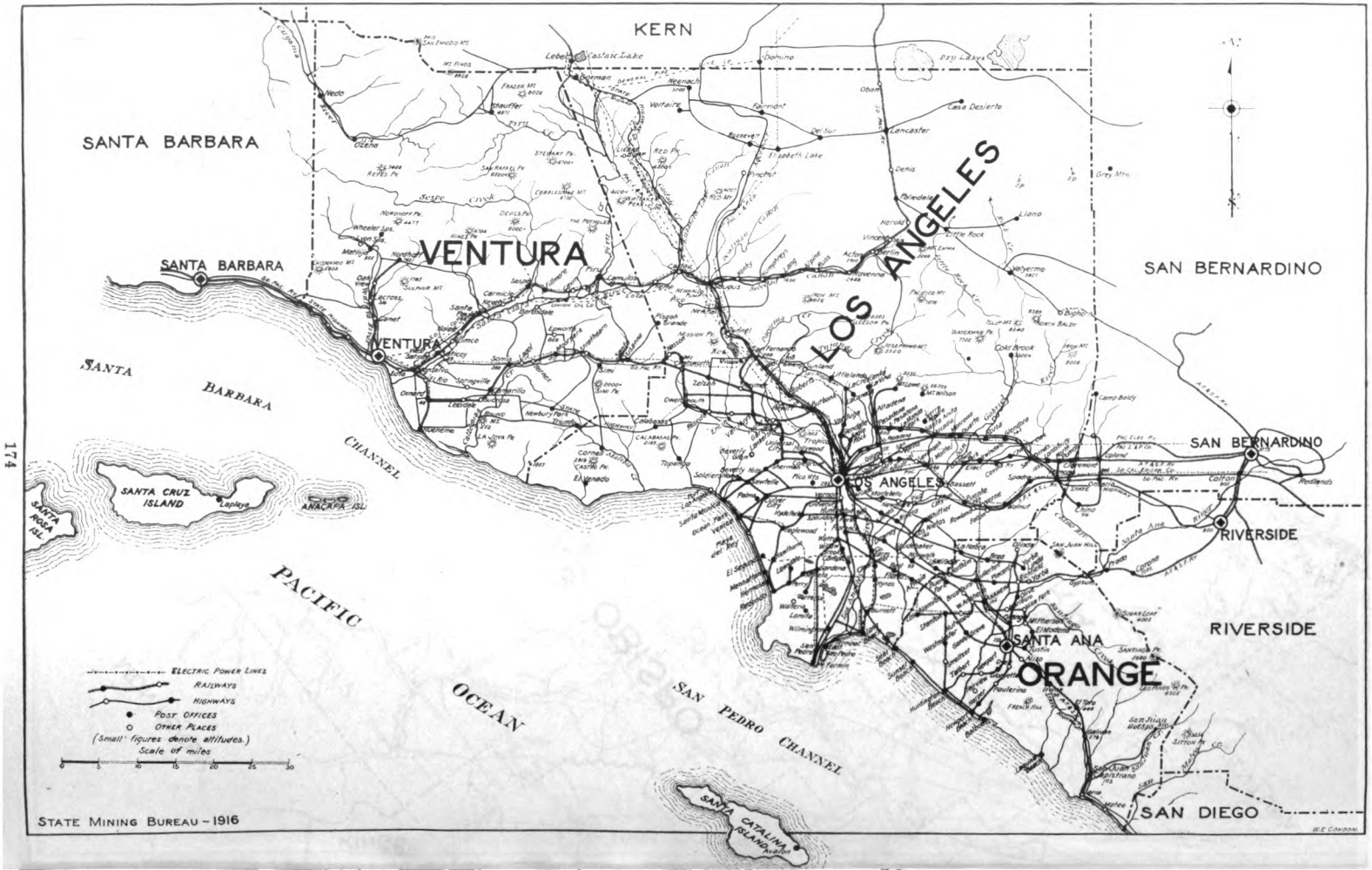

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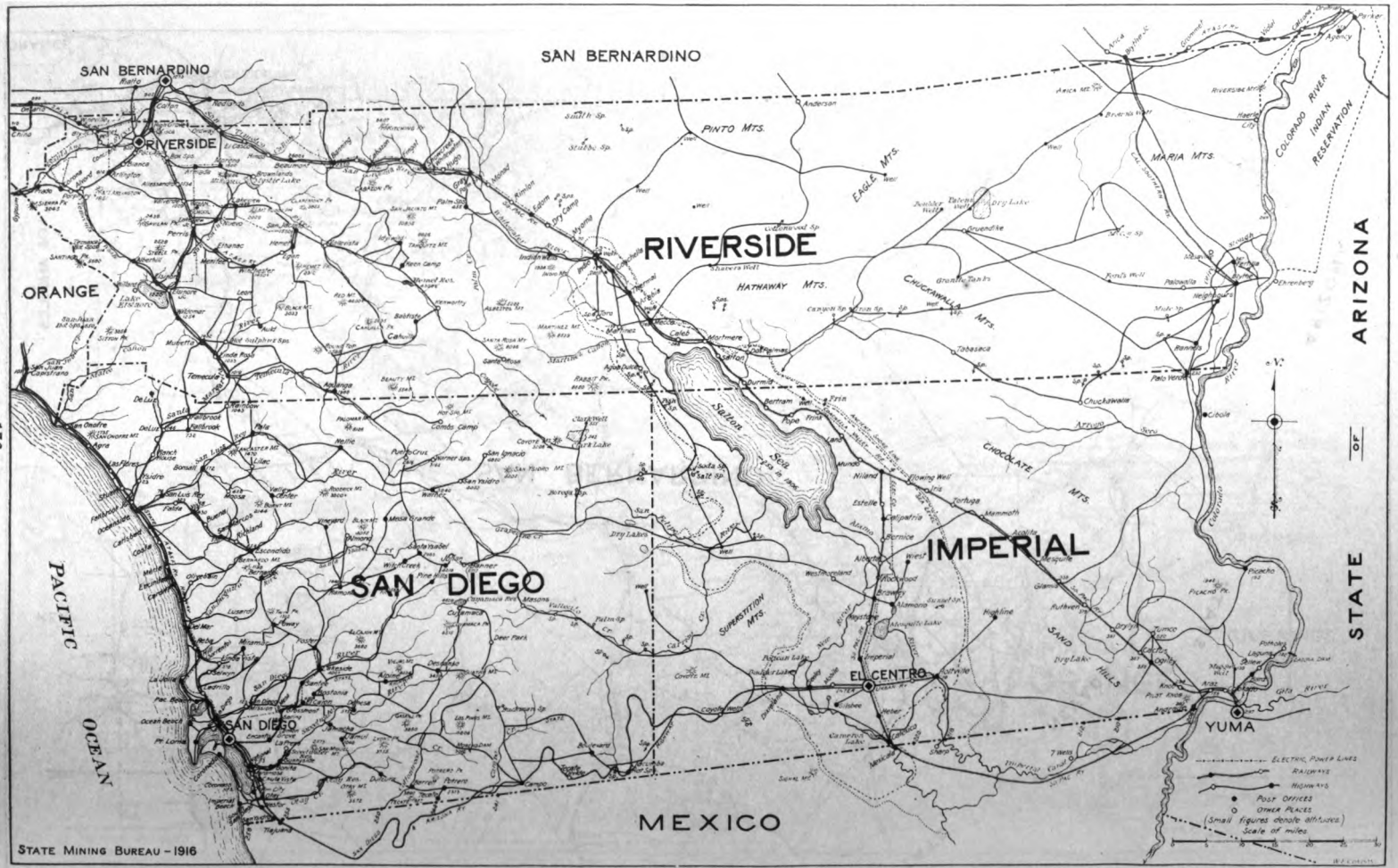

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